THE

AMERICAN NATURALIST

VOL. XXXII. *June, 1898.* No. 378.

THE FRESH-WATER BIOLOGICAL STATIONS OF AMERICA.

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THE fundamental purpose of all biological stations, both marine and fresh-water, is essentially the same. They serve to bring the student and the investigator into closer connection with nature, with living things in their native environment. They facilitate observation and multiply opportunities for inspiring contact with, and study of, the living world. They encourage in this day of microtome morphology the existence and development of the old natural history or, in modern terms, œcology, in the scheme of biological education.

The predominance of the marine station is but natural, for American biology was cradled at Nahant and Penikese. Until recently, practically all the great centers of biological investigation and instruction have been located almost within sound of the sea. It was also to be expected that the seaside laboratory would attract the inland biologist who is searching for a place in which the summer can be passed with both pleasure and profit, and that the abundance and novelty of the marine fauna would overshadow if not entirely eliminate all attention to the fresh-water fauna of the vicinity, attractive though it might be.

This supremacy of interest in marine biology is not, however, confined to the seaside laboratory; it finds its way into text-books and schoolrooms. Laboratory guides in which marine types very largely predominate are not unknown, and too many a teacher of biology in collegiate courses and in the secondary schools of our inland towns depends upon marine forms for laboratory study and demonstration, to the sad neglect of the fauna with which both he and his pupils come in daily contact. From a pedagogical point of view this element of remoteness in the objects of study is unfortunate, for it tends to abridge the sympathetic contact with nature and the development on the part of the pupil of a lively interest in the world of life about him, a feature of large cultural value in all biological education.

The writer has found a widespread feeling in biological circles that the fresh-water environment affords far less of value for investigation and instruction than the marine. Considered merely volumetrically, the marine fauna may well have the advantage, but all the general problems of biology can be approached with ease, and at times to even greater advantage at the fresh-water station; and, furthermore, in variety and richness the fauna of fresh water, in some localities at least, compares very favorably with that at the seaside. It may then be that one of the functions of the fresh-water station is to preserve and foster an interest in fresh-water life and to emphasize its availability and utility for purposes of instruction. In no sense of the word, however, are the marine and fresh-water stations to be regarded as rivals; each is the necessary complement of the other, and both alike have their place in the field of biology.

The movement which has resulted in the establishment of a number of fresh-water biological stations in the north central states in the past few years has had a variety of sources. Prominent among these have been, doubtless, the successful examples of the marine stations, and the desire on the part of inland workers to have near-at-hand resorts for summer work which should offer to their students analogous advantages without the expense attendant upon a trip to the seashore. The

existence in some of the states in question of natural history surveys under the patronage of the state has in a few instances been the means of furnishing the funds for the conduct of these enterprises. The fundamental reason, however, for the biological station movement is neither a mere local demand nor an opportune opening, but a deep-seated purpose on the part of the men who stand as sponsors for the stations, to extend biological exploration, to increase the facilities for, and raise the standard of, biological instruction in their respective states, and finally and principally to contribute in some substantial way to the solution of some of the fundamental problems of biology, as, for example, the problem of variation, or the œcology of a river system.

Aside from the three stations noticed at length in this article, whose past history and material equipment entitle them to recognition as permanent institutions, there have been other enterprises which have done the work of a biological station, though not formally organized as such. The fortunate situation of the University of Wisconsin upon the shores of Lake Mendota, rendering unnecessary the establishment of an independent outpost, has made it possible for Professor Birge to carry on for several years past a series of connected observations upon the Crustacea of the plankton. The results of this work — a credit to any biological station — have been published by the Wisconsin Academy of Sciences.[1] The work of exploration in this state will be continued elsewhere during the present summer under the auspices of the State Survey.

The Michigan Fish Commission for several years carried on a biological examination of many of the smaller lakes of the state. Professor Reighard, of the University of Michigan, was in charge of the work, and in 1893 made a more thorough and systematic survey of Lake St. Clair. In 1894 a biological examination of the northern end of Lake Michigan was made by a party in charge of Dr. H. B. Ward. The results of these explorations have appeared from time to time in the Bulletin of the Commission. The work upon the Great Lakes will be resumed this summer under the auspices of the United States

[1] See review in this journal, No. 376, pp. 282–284.

Fish Commission by a party in charge of Professor Reighard, located at Put-in-Bay, in Lake Erie.

The University of Minnesota maintained for several years at Gull Lake a laboratory for summer work in connection with the Natural History Survey of that state. The establishment of a station has also been agitated in the state of Iowa during the past year. The University of Rochester is raising funds for the equipment of a station at Hemlock Lake, thirty miles south of Rochester, in western New York. This station will probably be opened next year, and will occupy buildings furnished by the city of Rochester. Instruction will be the main purpose of its organization.

The description of the Ohio station, given herewith, was one of the last pieces of work which its late director, Prof. D. S. Kellicott, accomplished before his fatal illness. The account of the Indiana station was furnished by its director, Prof. Carl Eigenmann.

THE LAKE LABORATORY OF THE OHIO STATE UNIVERSITY.

This laboratory is at Sandusky, on the grounds of the city's pumping station, near a cove of the East Bay. It consists of the second story of the State Fish Hatchery; there is one large room with work table, and three small ones for the use of investigators. The supply of trawls, plankton nets, seines, insect nets, etc., is ample. Microscopes, reagents, and glassware are supplied as needed from the university. There is also a small sailboat. The most pressing needs, by way of equipment, are better aquaria and a larger and more seaworthy boat; these will be added in the future.

Sandusky is as favorable a place for the study of fresh-water fauna and flora as is likely to be found on the Great Lakes. Many species of fish spawn in the bays or about the adjacent islands; crustaceans, worms, sponges, and protozoans are abundant. If one wants a most favorable place to study water birds, none is better in this latitude than the extensive marshes and sand dunes in the vicinity of Sandusky.

The purpose of the station is simply to afford a convenient plant for students and instructors of the State University first, and any one else when there is room, to study the living forms of this favorable locality.

Work has been carried on at Sandusky for two summers. Some of the lines of work undertaken, in which progress has been made, are these: (*a*) fishes inhabiting the bays, their food and parasites; (*b*) nesting habits of the marsh-inhabiting birds; (*c*) the aquatic insects; (*d*) the Rotifera; (*e*) the fresh-water sponges; (*f*) the crayfishes. Some progress has been made in determining the amount, character, and distribution of the plankton.

The collections are mostly transferred to the university, and abstracts of the work reported to the Ohio Academy of Science, usually as reports of progress on the biological survey, which is being directed by a committee of the academy. The station will be open but a short time in 1898, as the survey is to be carried on in other parts of the state.

This station is in no sense a school; every man looks after his own interests, giving and receiving advice, as occasion may demand.

The Biological Station of Indiana University.

A biological station for the Indiana University was suggested by Professor Eigenmann to the Board of Trustees in 1893, and he was enabled to open the station in 1895. The object in view being well defined and a number of localities being from a natural standpoint equally suitable, the location was determined by the finding of an old boathouse suited to the purpose on the shores of Turkey Lake. Windows were cut, boards laid to cover the larger cracks in the floor, and work begun.

As there was no fund available to defray the expenses of the station, a number of courses of instruction were offered to raise the necessary money, to permit a few "laboratory grubs" to attain their full development, and to start a few other students at work in the natural habitat of the beginner in zoölogy — the woods, the water, and the fields.

During that year a map was made of the lake bottom, a brief survey of the animal contents was undertaken, and material was collected for the main object of the station, the study of variation.

The trustees appropriated in the two years following $200 and $300, respectively, to provide permanent equipment to carry on the work and furnish accommodations for additional students.

INDIANA BIOLOGICAL STATION.

A building 18×55 feet, two stories high, was erected for the station by the owner of the ground.

The conditions for biological work, coupled with camp life on a fine lake, five miles from the nearest village, free from the university lecture-hour appointments, proved so attractive that during the second summer the number of students rose from 19 to 32, and in the third to 68.

The advantages for biological work at a biological station all recognize to be ideal; here some of the enthusiasm of the older natural history is aroused. To the special advantages mentioned should be added the acquisition on the part of the student of the ability to help himself, to adapt himself to new environments. Most of the failures by teachers of biology in the secondary

as well as higher schools have come from their inability to work with the means found at hand, and their inability to adapt themselves to a new environment.

The object of the station can best be expressed in the words of the first announcement.

Research. — The main object of the station will be the study of variation. For this purpose a small lake will present a limited, well-circumscribed locality, within which the differences of environmental influences will be reduced to a minimum. The study will consist in the determination of the extent of variation in the non-migratory vertebrates, the kind of variation, whether continuous or discontinuous, the quantitative variation, and the direction of variation. In this way it is hoped to survey a base line which can be utilized in studying the variation of the same species throughout their distribution. This study should be carried on for a series of years, or at least be repeated at definite intervals to determine the annual or periodic variation from the mean. A comparison of this variation in the same animals in other similarly limited and well-circumscribed areas, and the correlation of the variation of a number of species in these areas will demonstrate the influence of the changed environment, and will be a simple, inexpensive substitute for much expensive experimental work.

For this work the situation of Lake Wawasee, surrounded as it is by other lakes, some of them belonging to other river basins, will be admirably adapted.

In connection with this study of the developed forms the variation in the development itself will receive attention; for instance, the variation in segmentation, the frequency of such variation, and the relation of such variation in the development to the variation in the adult, and the mechanical causes affecting variation.

Instruction. — Courses of instruction which ordinarily cannot be given in the university's laboratories during the college year will be offered, and credit given on the university's records. The courses are as follows:

1. *Elementary work.* The class will collect, preserve, and study a series of animals occurring in the neighborhood of the station. Emphasis will be laid on the nature of the fresh-water fauna, and the correlation and adaptation of organisms. The entire day will be given to collecting excursions, laboratory work, and lectures, with individual work on Saturdays. No special preparation is needed. (Teachers may collect material for their classes, but alcohol for this purpose will not be furnished.) 2. *Embryology* and life history of fishes and other local forms. 3. *Special investigations* in the variation of non-migratory vertebrates and survey of the physical and biological conditions of Lake Wawasee.

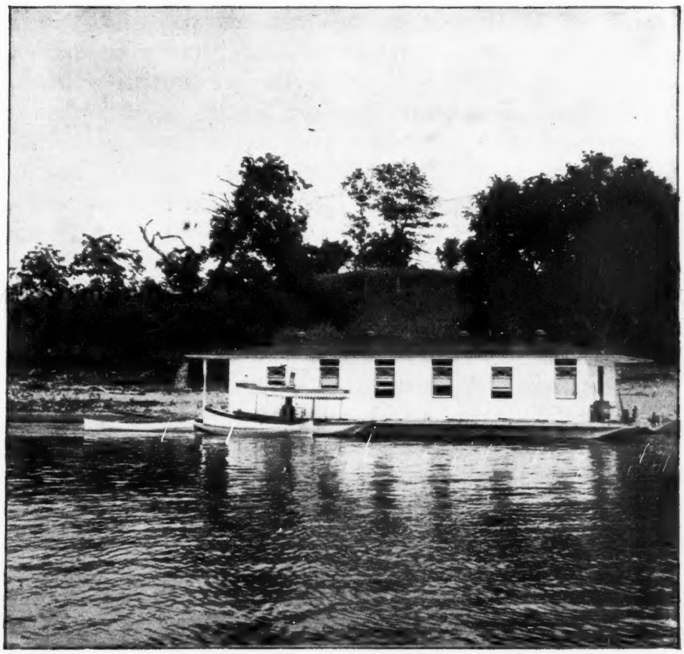
During the second and third years maps of a number of northern lakes have been prepared. A general survey of the Turkey Lake fauna has been published. A very large amount of material has been collected to illustrate the annual variation, the birth-mean, and the effect of selective destruction. Two papers on variation have been published, but most of the material is still to be examined.

As to the future, the Winona Assembly has offered to erect two buildings, each 20 × 57 feet and two stories high, on the shores of Eagle or Winona Lake, Indiana, eighteen miles from our present location. This lake had been decided upon for the location of the station in the first instance, but was given up because no suitable building was available. The trustees of the university have agreed to appropriate $1000 for the permanent equipment of these buildings. They will be ready for occupancy in 1899. Aside from laboratories for bacteriology, physiology, embryology, zoölogy, and botany, there will be about a dozen small rooms for the instructors and for visiting naturalists who care to make use of the facilities offered. Courses of instruction will be offered in the subjects mentioned. The study of variation will be continued and other problems will be added, one of which will be the rearing of cave animals in the light.

ILLINOIS BIOLOGICAL STATION.

For a number of years the investigation of the aquatic life of the lakes and streams of Illinois has been prosecuted under the auspices of the State Laboratory of Natural History, in connection with the Natural History Survey now in progress in the state, under the direction of Prof. S. A. Forbes. From time to time parties equipped for biological exploration have been sent out, and have occupied temporary posts of observation on the Mississippi River or elsewhere. No permanent station was established, however, until April, 1894, when, with the joint support of the State Laboratory of Natural History and the University of Illinois, a station was opened upon the Illinois River at Havana. For the equipment of this work $1800 was

appropriated. For the two years beginning July 1, 1895, this joint support was continued, $2500 being appropriated by the legislature for equipment, and $3000 per year for running expenses. In 1897 the appropriation for running expenses of the station was renewed, but the whole amount was given



ILLINOIS BIOLOGICAL STATION.

through the State Laboratory of Natural History, and the name of the station was changed from "The Biological Experiment Station of the University of Illinois" to "Illinois Biological Station."

From its beginning the station has enjoyed the deep interest and wise guidance of its experienced director, Prof. S. A. Forbes. Until July 1, 1895, the station was in the immediate charge of Prof. Frank Smith; since that date the conduct of its operations has been in the hands of the present superintendent.

The equipment of the station consists of a house boat or floating laboratory, 20 × 60 feet over all, well lighted and ventilated, containing a private laboratory and office, a main laboratory, a storeroom, and a kitchen. In the center of the larger laboratory stands a long sink for aquaria, supplied with water from an overhead tank. The tables in the laboratories will provide working accommodations for twenty persons. A steam launch, licensed to carry seventeen passengers, furnishes a convenient means of transit to and from the various collecting grounds, and a half-dozen rowboats add to the facilities for field operations. The station is supplied with nets and seines of various kinds for the collection of fishes and other aquatic vertebrates, with a collecting lantern and nets for field work in entomology, with a large number of breeding cages for the rearing of aquatic larvæ of insects, with dredges, sieves, dip nets, and Birge nets for bottom and shore examinations, and with tow nets, plankton nets, pumps, centrifuges, and counting machines for the qualitative and quantitative investigation of the plankton. The laboratory is also supplied with a number of aquaria, a liberal allowance of glassware and reagents, and in its more extended summer operations is further furnished from the biological laboratories of the university.

The library of the State Laboratory of Natural History is exceptionally complete in the literature of fresh-water fauna and flora, and is available for the use of the biological station. The leading monographs and many of the scattered papers dealing with the Protozoa, Rotifera, Oligochæta, Entomostraca, and aquatic insects are provided. Systematic and faunistic work upon these groups is further facilitated by the large number of collections in the possession of the state laboratory from the waters of the state and many other parts of the continent. Among the collections is a series of named European Entomostraca sent by eminent specialists (Sars, Schmeil, Lilljeborg, and Poppe); these are of great value in unraveling the synonymy of this group, and in establishing the validity of American species or their identity with European forms. They also afford a basis for the study of comparative variation in the two continents.

The field of operation of the station is, for the present at least, the Illinois River and its related waters. Geologists tell us that this stream and its bottom lands occupy the bed of an ancient river, a former outlet of Lake Michigan. The present flood plain is but slightly above the level of the river, and overflows are, therefore, of more than usual extent and frequency. The fall of the stream is very slight, about thirty feet in two hundred and twenty-five miles, and at times of flood the area covered is over seven hundred square miles. Over fifty-six square miles in the field of the station's operations are submerged at high water, and of these seventeen represent the river, lakes, bayous, and permanent marshes of low-water stages. The extreme fluctuation in the river level recorded at Havana is eighteen feet, and a rise to sixteen feet above low water is not unusual in the spring or early summer. Owing to dams, the river at low water is practically a series of slack-water pools. The river thus presents a considerable change in conditions during the year. Although at high water it is practically a unit in environment, as the water recedes a number of distinct and characteristic aquatic areas emerge, and are quickly differentiated by their peculiar fauna and flora. At low water there thus lies within easy reach of the station a wide range of situations, including the river and its tributary streams, Spoon and Quiver Rivers, a shallow ephemeral lake quite free from vegetation, a large impounding lake and bayou without tributaries, several spring-fed lakes with different amounts of vegetation, and a number of marshes of varying degrees of permanence. This extremely varied environment, and the considerable and sometimes sudden fluctuations in the water level, add greatly to the complexity of the biological problems with which our station has to deal.

The fertility of the drainage basin of the river, the large amount of sewage emptying into the stream, and the rich alluvial soil of the bottom lands favor the growth of aquatic vegetation. At low water a rank growth of Ceratophyllum fairly chokes many of the lakes, and at times even encroaches upon the river. Nelumbium and Nymphæa, Lemna, Wolffia, and Azolla abound, and water-blooms of Euglena, Carteria,

Anabæna, and Clathrocystis are of frequent occurrence. The plankton is remarkable alike for the large number of individuals and of species it contains, while in volume per cubic meter it, at times, exceeds almost all published records. The fauna, as well as the flora, is conspicuous for its abundance and variety. Although no efforts have been made to accumulate complete faunal lists, over one hundred species of Protozoa have been recorded, as well as a like number of Rotifera. Spoon River has long been noted for the abundance, variety, and size of its Unionidæ, thirty species of which are known to occur in the vicinity of Havana; there are in addition forty-five other species of aquatic Mollusca, largely univalves. Through the efforts of Professor Smith over thirty species of Oligochæta have been found, including a number of new and interesting forms. Aquatic insects abound, over three hundred and fifty species being known to occur in the vicinity. An interesting feature of the richness of the fauna is the occurrence of certain zoölogical rarities whose range, as hitherto known in this continent at least, has been limited; as, for example, Urnatella and Lophopus among the Bryozoa, and Trochosphæra among the Rotifera.

The essential objects and general methods of the Illinois station are best expressed by its director, Professor Forbes, in his last biennial report.

It is the general, comprehensive object of our biological station to study the forms of life, both animal and vegetable, in all of their stages, of a great river system, as represented in carefully selected typical localities. This study must include their distinguishing characters, their classification and variations, their local and general distribution and abundance, their behavior, characteristics, and life histories, their mutual relationships and interactions as living associates, and the interactions likewise between them and the inanimate forms of matter and of energy in the midst of which they live. We are, in short, to do what is possible to us to unravel and to elucidate in general and in detail the system of aquatic life in a considerable district of interior North America.

So vast a subject must of course be intelligently divided and studied part by part, in some systematic order, to avoid a dissipation of effort and to insure the speedy attainment of some definite and tangible results. Its most obvious divisions are the systematic, the biographical, and the œcological;

and this is the order, broadly speaking, in which the general investigation must be carried on. Both systematic and biographical biology have a high independent value in our scheme, but both are with us chiefly means to the remoter end of a study of the interactions of associate aquatic organisms, and of their relations to nature at large. It is thus the œcological idea which is to lead in the organization and development of our work. A systematic survey of the biological assemblage is a necessary preliminary step, and the tracing of life histories and the recognition and description of immature stages is a scarcely less essential prerequisite; for without the knowledge which these studies are to give us, it would be obviously impossible to make any comprehensive study of variations, distribution, and œcological relationships.

The œcology of the Illinois River is greatly complicated, and the difficulty of its study intensified, by certain highly and irregularly variable elements of the environment. Apart from those secular and more or less inconstant features of climate and weather which must be taken into account wherever such studies are prosecuted, we often have here the evidently very large and highly intricate reactions produced by periodic variations in the river level, and the consequent enormous extensions and corresponding diminutions of the mass of the waters and of the area covered by them. Fortunately for the possibilities of success in so difficult a field, progress in it does not require that the entire system of life should be studied as a unit at first. Special problems may be selected, of a kind to be brought easily within the available time and the capacities of the individual investigator, which, being worked out one by one, may be later brought together as contributions to a solution of the larger problems involved.

In actual practice it has been found that our work may best be opened up by comprehensive studies of the classification, such as will give us a critical knowledge of all the forms occurring in our field, and access to the published literature of each; and by parallel or slightly subsequent studies of their habits, life histories, and local distribution and abundance.

The principal methods of the biological station are those of field and laboratory observation and record, collection, preservation, qualitative and quantitative determination, description, illustration, generalization, experiment, induction, and report.

By close and persevering observation in the field, we learn much of the actions, habits, and haunts of animals, of the special conditions under which they live, and of many similar matters which cannot possibly be learned in any other way; and not a little of this knowledge is necessary to an intelligent treatment of both general and special problems in biology.

The acute, persevering, sympathetic observer of living nature — the "old-fashioned naturalist," in short — is best to be understood as a "synthetic

type," all of whose best qualities should be not only preserved but intensified among his variously differentiated progeny. It is the biological station, wisely and liberally managed, which is to restore to us what was best in the naturalist of the old school united to what is best in the laboratory student of the new.

As our work progresses and special problems are taken up for separate and continuous investigation, the experimental method will necessarily come prominently into use. The object of biological experimentation is the interpretation of nature, and, like all intelligent experimental work, it must be suggested and guided by observation and hypothesis. With us it is the œcological field in which experiment is especially called for. Given certain phenomena of local distribution, of relative abundance, of association, of habit, of variation, and the like, whose causes it is desirable to ascertain, it is incumbent upon us, by a critical and exhaustive study of the environment to find the materials for rational hypotheses as to such causes, and to test such hypotheses by experimental procedure. It is thus always the field observation, or the laboratory observation made under conditions which involve the least practicable departure from natural conditions actually existing, which must precede and suggest the experiment. The method and the general object of this work resemble thus more closely, on the whole, those of the agricultural experiment station — which is, indeed, a biological station under another name and devoted to a special end — than those of the laboratory of experimental physiology; and it is because ours is to be in the end and in its final objects a station for the solution, by experimental methods, of both special and general problems in the field of œcology that it was christened by its official board of control the Biological *Experiment* Station of the University.

As the work of the station is still in its earlier stages, the papers thus far published give the results of the preliminary explorations, and, consequently, are of a systematic, faunistic, or biographical character in the main. A report upon the aquatic Hymenoptera and a considerable portion of the Diptera and Lepidoptera, by Mr. C. A. Hart, has already been published, and additional papers upon the Odonata and Ephemeridæ are in preparation. It is the purpose of these papers to elucidate the life histories of the insects of these groups by giving a detailed account of the identified eggs, larvæ, and pupæ, together with a discussion of their seasonal and local distribution, their habitat, food, etc. As a result of the breeding work carried on at the station, immature stages, hitherto undescribed, of two hundred and twenty-five species have been obtained.

The investigation of the Oligochæta has been carried on for several years; thirty species are known to occur. Two new genera and at least seven new species have been found. Three papers have appeared upon the subject, and a final report is in preparation by Professor Smith. The results of the examination of the Turbellaria of the station have been published by Dr. W. McWoodworth, seven species being found, of which two are new. Some new species of Rotifera and Protozoa have been described by Mr. A. Hempel, and a report upon the local and seasonal distribution of these groups has been completed. Three papers upon the Entomostraca, prepared as zoölogical theses by students in the university, have been based in part upon station collections. A report upon the Ostracoda of North America, by R. W. Sharpe, a revision of the North American species of the genus Diaptomus, by F. W. Schacht, and a paper upon the North American species of Cyclopidæ, by E. B. Forbes, have appeared, and a fourth paper upon the remaining genera of the Centropagidæ is ready for the press.

The plankton work of the station has resulted in the accumulation of a large number of collections and a mass of data upon the local and seasonal distribution of pelagic organisms. Considerable attention has been given to the sources of error in the plankton method, and efforts have been made to secure a reliable and convenient basis for the quantitative and statistical study of the aquatic world.

Although the station was established primarily for purposes of investigation, its relation to biological education has not been neglected. As soon as permanent quarters were occupied, the facilities of the station were thrown open to students and teachers, twenty of whom availed themselves of the privilege in 1896. No formal instruction was given, each person following his own inclination as to the line of work undertaken, with such incidental guidance and assistance as the station staff could afford. A summer school with definite courses, especially for teachers, was planned for 1897, but, owing to the temporary loss of funds for the maintenance of the station, the project was abandoned. For the summer of 1898 an offer is made of elementary and advanced courses in both botany and zoölogy.

These courses will be supplementary to regular university work, and will, to some extent, be especially adapted to the needs of teachers of biology in the secondary schools. Tables at the station will also be reserved for the use of visiting investigators and students of special subjects.

For the successful accomplishment of the fresh-water work certain desiderata are evident: more precise and reliable methods for the quantitative and statistical study, not only of the plankton, but also of shore and bottom forms; more biographical work, studies of life histories in the broadest sense of the term, including precise observations upon the environment and its relation to the life cycle; more models of experimental work that shall make clear the feasibility of the application of the methods of the physiological laboratory to the study of the factors of environment; more biological stations, so that the conclusions arrived at in one locality may be extended and corrected in a score of others; and, finally, some biological Frœbel, who shall demonstrate the disciplinary and cultural value of œcology as a field of biological instruction and establish a standard for others to imitate.

The future of the fresh-water biological stations is bright with the hope of accomplishment, but their problems lie not wholly along the beaten paths of the past. In their work we may look for the happy combination of the sympathetic observation of the old-time naturalist, the technical skill and searching logic of the morphologist, and the patient zeal and ingenuity of the experimental physiologist, a combination, let us hope, that shall unlock not a few of the secrets of the world of life.

ON THE IDENTIFICATION OF FISH ARTIFICIALLY HATCHED.

HERMON C. BUMPUS.

Although the United States Fish Commission has annually hatched and planted many millions of young fish, and although the planting has often resulted in the apparent increase in the number of adults where the plantings have been made, there is nothing but circumstantial evidence to show that the fish appearing in increased numbers are really the adults of the young artificially produced. The recent excessive abundance of cod along the shores of New England is probably the result of extensive operations at the Woods Holl hatchery. The facts that these fish were small when they first appeared, that they have since increased in size, that they have occurred in localities where cod had never before been caught, and that they are reported to be of a different color from the native variety are interesting, although to the sceptical they are not absolutely convincing. There is need of some scheme whereby the adults of fish hatched artificially may be distinguished from those native to the locality.

To mark the fry is, of course, out of the question, but is it not possible that the fry mark themselves, *i.e.*, is there not a slight difference between the fish of the same species but of different localities, and if there is this slight difference, does it not present itself in a measurable manner?

The careful examination of a large number of periwinkle shells[1] (*Littorina littorea*) has shown that localities even near together are characterized by shells of different proportions. This fact has warranted the examination of a number of fish for the purpose of seeing if they too are not subject to similar varietal changes.

During the latter part of March of the present year, while

[1] *Zoölogical Bulletin*, vol. i, No. 5, February, 1898, p. 247.

at the Laboratory of the United States Fish Commission, I examined several hundred winter flatfish (*Pleuronectes americanus*) with the following results :

Of 100 flatfish collected at Woods Holl, only one had 62 dorsal fin-rays, seven had 63, twelve had 64, twenty-two had

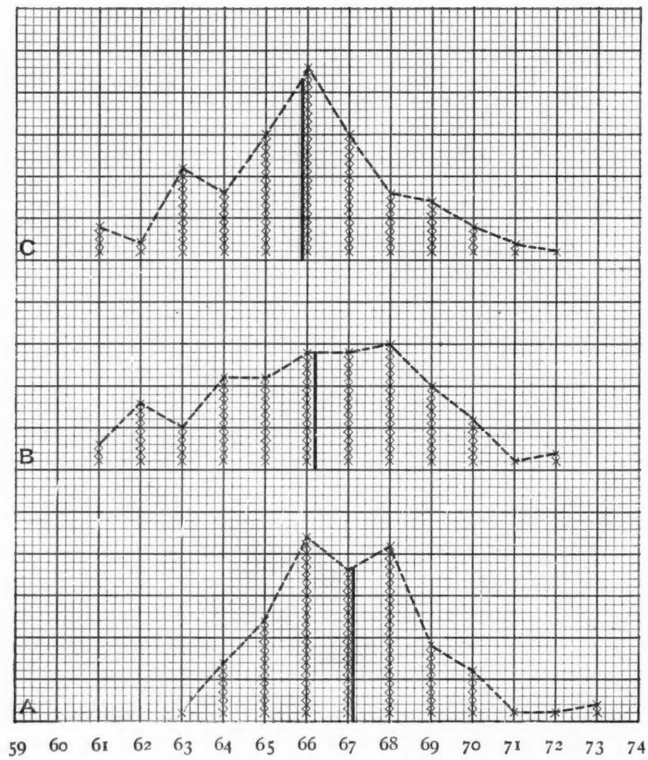


FIG. 1.

65, etc., as represented by the ordinates of curve *A* in Fig. 1. The amplitude of variation is between 62 and 72, the arithmetical mean being 66, represented by the vertical line at the right of 66.1, curve *A*. The curve drawn through the upper ends of the ordinates represents graphically the distribution of the 100 variants around this mean.

If we now tabulate the dorsal fin-rays of an equal number of flatfish from another locality, it is evident that if the fishes in both localities are alike, the curves will coincide. If they are different, even slightly so, the lack of coincidence will indicate the difference. The curve drawn at *B*, Fig. 1, is based on the enumeration of the dorsal fin-rays of 100 flatfish taken at Waquoit, Mass., from a small bay only eight miles east from Woods Holl. Compared with curve *A*, the Waquoit curve lies further to the left, has a longer base, and a less altitude. The Waquoit collection thus contains several fish, the number of dorsal fin-rays of which are less in number than those of fish taken at Woods Holl. The Waquoit fish are more variable, the amplitude at Woods Holl being from 62 to 72 (eleven points), while the amplitude at Waquoit is from 60 to 71 (twelve points). The depressed curve of distribution in the second curve is an indication of greater variability and general indifference to the "ideal mean." The arithmetical mean, represented by the vertical line, is 65.2, the Waquoit fishes averaging about one dorsal fin-ray less than the Woods Holl specimens.

Curve *C* represents the distribution of 100 flatfish from Bristol, R. I., from a body of water located about fifty miles west of Woods Holl. Compared with curve *A*, the Bristol curve lies further to the left and has a broader base, though its culminating point is very definitely indicated. The arithmetical mean is 64.9.

It is thus seen that there is a measurable difference between collections of fish from different localities, even though the fish *individually* present no perceptible difference.

There is correlated with the increase or decrease in the number of dorsal fin-rays, an increase and decrease in the number of anal fin-rays, as shown in Fig. 2. The Woods Holl specimens average a large number of dorsal and also a large number of anal fin-rays, 66.1 dorsals and 49.7 anals. The Waquoit specimens average a less number of dorsal fin-rays (65.2), and they also have a less number of anal fin-rays (48.6). The Bristol specimens average only 64.9 dorsal fin-rays and 48.7 anal fin-rays. The individuals also partake of this corre-

lation, those having a larger number of dorsal fin-rays tending towards the possession of a larger number of anal fin-rays.

If it is proposed to test the result of re-stocking a locality in which a species of fish has become reduced in numbers, it is necessary to first determine the "curve of distribution" from

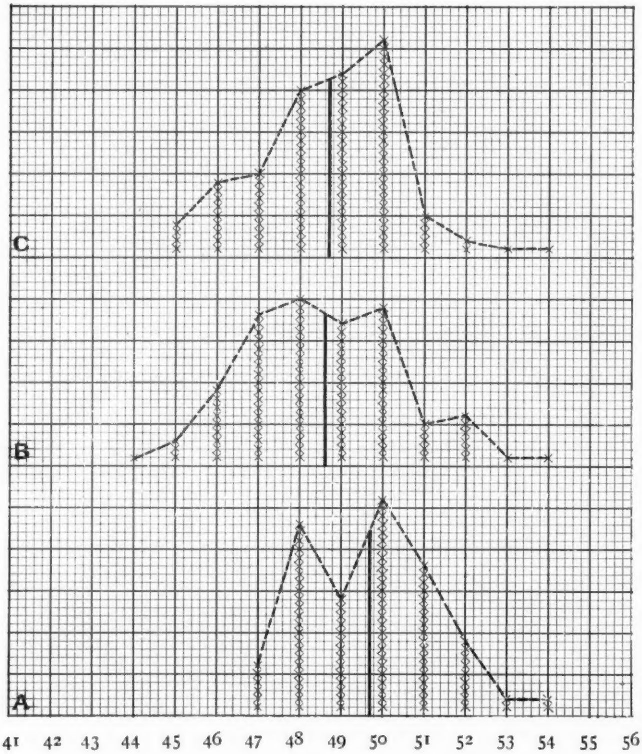


FIG. 2.

fish native to the locality, and this curve may be based on any measurable structural character, such as the number of fin-rays, the number of scale-rows, or the number of vertebræ. One must then determine the "curve of distribution," for the same structural character, of fishes of the same species, but abundantly found at another locality, from which the "brood fish"

are to be taken. After the "planted fish" have had time to mature, new curves should be plotted for the first locality. If these curves are practically the same as those originally made, it is reasonable to conclude that the re-stocking has been ineffectual. If, however, the new curve approaches the curve of the locality from which the "brood fish" were taken, it is reasonable to conclude that the influence of the foreign specimens has been felt, and the re-stocking has been effectual.

The following objections may be raised to the above method:

(1) It may be that, due to the small number of specimens (100), the curve *A* is not characteristic of the Woods Holl specimens, and its difference from curve *B* is only accidental. To test this source of possible error I have examined three separate groups of flatfish, all from the same locality, each group containing 100 specimens. The resulting curves are strikingly alike. Of course it would be much more satisfactory to base all the curves on the enumeration of the fin-rays of one thousand rather than one hundred specimens, but even one hundred specimens yield fairly definite results, though the curves are somewhat uneven.

(2) It may be that the variation in the position of the curves is a result of age, *i.e.*, the fishes from Woods Holl averaged a larger number of fin-rays because they were somewhat older.

If there is an increase in the number of fin-rays on the part of the older specimens, this increase can be readily detected by simply comparing the average number of fin-rays of the younger with the average number of fin-rays of the older fish. Fifty-three young fishes, less than 10 inches in length, have a mathematical average of 66.1 dorsal fin-rays. Forty-seven older fishes from the same locality, all over 10 inches in length, average practically the same number of fin-rays, *i.e.*, 66.3. In this collection of 100 fishes, the fourteen smallest have a greater average number of fin-rays than the fourteen largest. There is then no material increase in the number of fin-rays with increase in age.

(3) It may be that the variations tabulated in Fig. 1 are the result of environmental conditions expressed upon the fry and young — acquired characters of questionable hereditary value;

i.e., it may be that the fry reared at Woods Holl would attain to a larger number of dorsal fin-rays than the *same* fry reared at Waquoit.

While certain experiments that the writer has made induce him to believe that these variations in the number of dorsal fin-rays may be deep-seated blastogenic characters, the influence of the environment, even if it should affect the ontogenic process, cannot vitiate the method, for if it is insisted that certain external influences may affect the fry *after* liberation from the hatchery, and the results of these influences are expressed by a change in the fin-ray formula, it must also be equally true that the more extreme and unusual environmental conditions imposed upon the still younger organism while *within* the hatchery, will leave their stamp also, and the artificially hatched fish will thus present some peculiarity, acquired though it may be, which will be brought out by the plotting of "curves of distribution."

THE WINGS OF INSECTS.

J. H. COMSTOCK AND J. G. NEEDHAM.

CHAPTER III (*Continued*).

IX. THE VENATION OF THE WINGS OF HYMENOPTERA.

The Hymenoptera belong to the series of orders in which the direction of specialization of the wings results in a reduction in the number of the wing-veins. This is true of the wing as a whole, the reduction taking place in the anal area of the wing as well as in the pre-anal area. We have found no representative of the order in which all of the veins have been preserved ; and in the more specialized forms nearly all of the veins have disappeared.

A study of all of the families of the order shows that the most generalized of living forms, so far, at least, as concerns the structure of the wings, are to be found in the families Siricidæ and Tenthredinidæ. In these we find a close approximation in the number of wing-veins to the hypothetical type. But even here the courses of the branches of the forked veins have been greatly modified. These changes have been so great that the determination of the homologies of the wing-veins in this order was one of the most difficult problems of the kind that arose in the course of the study of the wings of insects.

This determination was made by the senior writer from an examination of the wings of adults before our present method of ontogenetic study was devised.[1] In the course of the present investigation we have endeavored to test the accuracy of his conclusions by a study of the tracheation of the wings of hymenopterous pupæ. We have found, however, that although the wings of the more generalized forms are abundantly supplied with tracheæ, the courses of these tracheæ have not been modified in the same way as have the courses of the veins with which they correspond. For this reason we are still forced to

[1] Comstock, *Manual for the Study of Insects*, pp. 603–607.

determine the homologies of the wing-veins by a comparative study of the wings of adults. We will, therefore, point out first what we believe to be the method of specialization of the

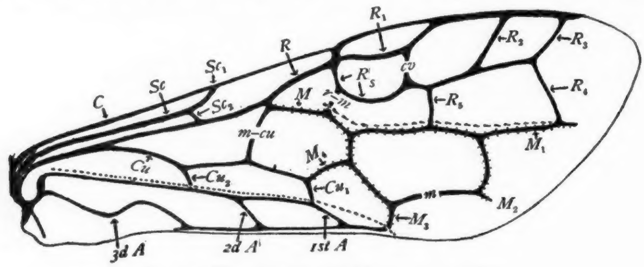


FIG. 38. — The veins of a typical hymenopterous wing.

wing-veins that has taken place in this order; and later we will discuss the nature of the changes that have taken place in the arrangement of the tracheæ.

The method of specialization of wing-veins which has taken place in the Hymenoptera can be most easily seen by a study of the fore wings of certain sawflies. The most useful for this purpose that we have found belong to the genera Pamphilius and Macroxyela. If we are right in our interpretation of the wings of these insects, there is preserved in each genus all of the primitive wing-veins with a single exception. And,

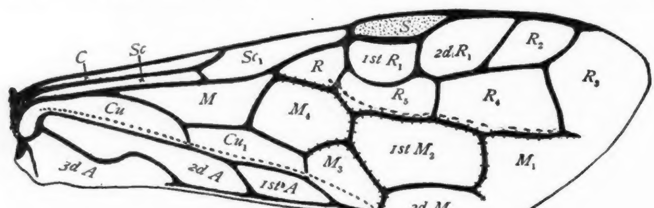


FIG. 39. — The cells of a typical hymenopterous wing.

as in each of these genera a different vein is lost, we are able to make a figure of a typical wing from a study of the two genera. Figs. 38 and 39 represent such a wing; in the former the veins are lettered; in the latter, the cells.[1]

[1] Figs. 38 and 39 represent the venation of the fore wing of Pamphilius, except that vein R_2, which is lacking in this genus, is added. This vein is well preserved

In the wings of these sawflies the anal furrow and the median furrow are both well marked, and are in the typical positions; that is, the anal furrow is immediately in front of the first anal vein, and the median furrow in front of the media. The furrows are represented by dotted lines in the figures.

In the anal area the three typical veins are preserved; but they coalesce to a considerable extent, both at the base and near the margin of the wing.

In the basal part of the pre-anal area the stems of the principal veins are as follows: the costa coincides with the costal margin of the wing (Fig. 38, *C*); the subcosta (*Sc*) is well preserved and is forked; back of the subcosta is a strong stem formed by the coalescence of the other three veins; the cubitus (*Cu*) soon separates from this stem, extending in a curve towards the anal furrow; while the radius and the media coalesce for about half their length. In order to make these veins more distinct in the figure we have marked the free portion of the media with cross lines.

When we pass from the consideration of the main stems to a study of the branches, we meet a much more complicated problem, a problem which could not have been solved by a study of Hymenoptera alone. But a knowledge of the methods of specialization of the wings of Diptera gives a key to an understanding of the wings of Hymenoptera.

In the preceding article of this series we pointed out that in many Diptera there is a marked tendency for veins to coalesce from the margin of the wing towards the base. In the Hymenoptera this tendency is much more marked and has been carried to a much greater extent, resulting in a very complicated arrangement of wing-veins, even in the most generalized members of the order.

If the reader will examine the series of figures illustrating the coalescence of veins Cu_2 and *1st A* in the Diptera,[1] he will find it easy to understand what has taken place in the Hymenoptera. In the Hymenoptera, however, both branches of the

in Macroxyela but in Macroxyela vein Cu_2 is lost. See Comstock, *Manual for the Study of Insects*, p. 606, for figures of the wings of these two genera.

[1] *American Naturalist*, vol. xxxii, No. 377, pp. 338, 339.

cubitus coalesce with the first anal vein; and this coalescence has proceeded so far that both branches cross the anal furrow and end in the anal vein remote from the margin of the wing.

It should be noted that vein Cu_2 is rarely preserved in this order, even in the more generalized forms. We have found it

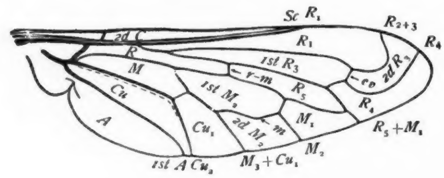


FIG. 40. — Wing of Pantarbes.

only in the genus Pamphilius. In Macroxyela[1] the position of the fork of the cubitus is indicated by a bend in this vein.

If the branches of the media be now examined, it will be seen that vein M_1 (Fig. 38) extends longitudinally near the center of the distal part of the wing, its primitive course being modified slightly if at all. Vein M_2 follows a course similar to the course of this vein in the dipterous genus Pantarbes (Fig. 40); so also does the medial cross-vein (Fig. 38, *m*). A comparison of the position of cells M_1, *1st* M_2, and *2d* M_2 in these two genera (Figs. 39 and 40) is very instructive.

Returning to Pamphilius (Fig. 38), we see that vein M_3 coalesces with the first anal vein, crossing the anal furrow near

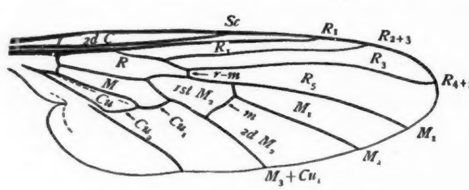


FIG. 41. — Wing of Rhamphomyia.

the margin of the wing. It is evident that the forces that are causing the branches of the cubitus to migrate along the first anal vein and towards the base of the wing are exerting a similar influence on this vein. It is also evident that vein M_4 and Cu_1

[1] Comstock, *loc. cit.*, Fig. 735.

coalesce at the tip, and that the migration of the united tips of these veins (marked Cu_1 in the figure) towards the base of the wing has so modified the course of that part of vein M_4 which is still free that this part of this vein extends towards the base of the wing. This change is very similar to the change in the course of vein Cu_2 in the dipterous genus Rhamphomyia (Fig. 41).[1]

A curious result of this change in the direction of the course of vein M_4 is that the cell M_4 has been closed and pressed back to the center of the wing (Fig. 39, M_4), and now lies in front of the free portion of vein M_4 instead of behind it. A somewhat similar modification of cell M_3 has been pointed out

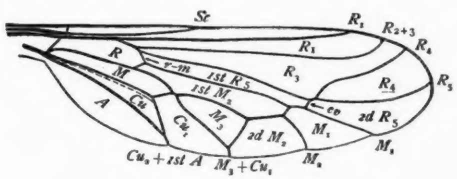


Fig. 42. — Wing of Eulonchus.

in the Diptéra; we repeat the figure of the wing of Eulonchus for comparison (Fig. 42).

Let us now consider the courses of the branches of the radius. Here again we can gain help from a study of dipterous wings. Observe in Pantarbes (Fig. 40) the coalescence of the tips of veins R_5 and M_1. In the Hymenoptera a similar coalescence of veins R_5 and M_1 has occurred; but it has proceeded much farther, so that the free portion of vein R_5 in Pamphilius (Fig. 38, R_5) is remote from the end of the wing and has the appearance of a cross-vein.

In the Hymenoptera vein R_5 has been followed in its migration along vein M_1 by vein R_4, which has now reached a stage in Pamphilius that is quite similar to that reached by vein R_5 in Pantarbes. But like vein R_5 it has the appearance of a

[1] At the time that the figures in Comstock's *Manual* were prepared it was believed that the media was typically three-branched. For that reason the vein which we now regard as vein M_4 was believed to be a cross-vein. The interpretation given above accords better with what we have since learned to be the typical form of the media.

cross-vein. In the fore wing of the honey-bee (Fig. 43) veins R_4 and R_5 still retain the appearance of branches of a forked longitudinal vein.

In Pamphilius vein R_1 is curved away from the costal margin of the wing to make room for a stigma (Fig. 39, *S*), and vein R_3 ends in the costal margin a short distance before the apex of the wing (Fig. 38). Vein R_2 has been lost in this genus, but is well preserved in certain closely allied forms,[1] and is, therefore, represented in the figure.

While the tips of the branches of the radial sector have migrated away from the apex of the wing, the bases of these

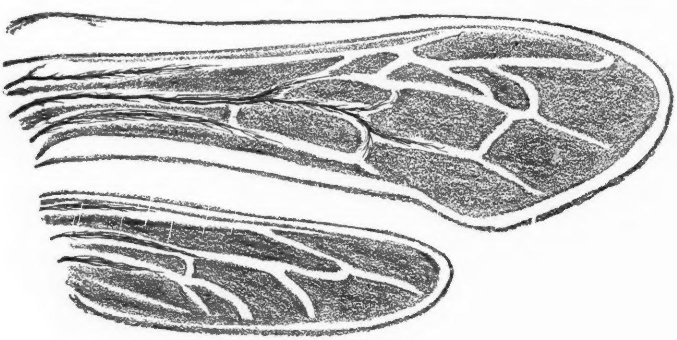


FIG. 43. — Wings of Apis.

branches coalesce in the opposite direction; from these two causes results the transverse bracing of the radial area of the wing, which is a very characteristic feature of the venation of the wings in this order.

The details of these changes will be made clear by an examination of Figs. 44 and 45. The former represents the primitive mode of branching of the radius; the latter, the radial area of the typical hymenopterous wing (Fig. 38). In the hymenopterous type veins R_{2+3} and R_{4+5} of the primitive type coalesce so far that the branches of the sector arise from a common stem; and the tips of all of them have moved away from the apex of the wing, veins R_2 and R_3 following the costal margin of the wing; and veins R_4 and R_5 following

[1] See p. 414, footnote.

vein M_1. In the Hymenoptera a cross-vein has been developed between veins R_1 and R_s. But this is not a peculiarity of this order; a similar cross-vein exists in many insects, and has been represented in our figures of the wings of a nymph of Nemoura.[1]

From the foregoing account it will be seen that even in the most generalized of living Hymenoptera there exists a highly

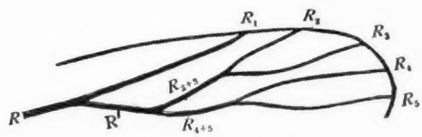


FIG. 44. — The typical radius.

modified wing venation. The indication of the details of the further modifications exhibited by the more specialized members of this order has already been done by one of us in another place. We will, therefore, merely refer to a single illustration.

When the fore wing of a honey-bee (Fig. 43) is examined it is found that, although this insect exhibits a wonderfully high development of instinctive powers, it retains a comparatively generalized wing venation. This wing, however, is much more modified than the fore wing of Pamphilius; and hence a comparison of the two is instructive.

In the honey-bee the subcosta is lost; so, too, is the second branch of the radius. Veins R_4 and R_5 retain a more general-

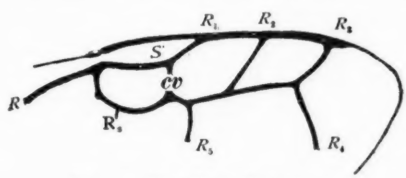


FIG. 45. — The radius in Hymenoptera.

ized condition than do these veins in the sawflies. The coalescence of the radius and the media extends farther than in Pamphilius, the base of the free portion of the media being carried farther from the base of the wing than the medio-cubital cross-vein (*m-cu*). This results in the base of the free

[1] *American Naturalist*, vol. xxxii, January, 1898, pp. 46, 47.

portion of the media (M) being V-shaped. No trace of the second branch of the cubitus remains; and vein Cu_1 appears as a short cross-vein, extending to the anal furrow near the middle of its course. But the most striking modification of all is exhibited by vein M_4; the tip of this vein in its migration towards the base of the wing has passed over an arc of nearly 180°, so that now it extends from the point where it separates from vein M_3 directly towards the base of the wing, and joins the medio-cubital cross-vein.

X. The Tracheation of the Wings of Hymenoptera.

In our studies of the wings of the more generalized insects we found a close correlation between the venation and the tracheation of the wings. It can be accepted as a firmly established fact that the courses of the wing-veins of primitive insects were determined by the courses of preëxisting tracheæ. And one of the principal objects of the present investigation was to endeavor to settle certain questions regarding the homologies of wing-veins by a study of the tracheæ that precede these veins.

The importance of this method of study has been well shown by the results which we have obtained. But we also found that in the Trichoptera[1] there is little correlation between the venation and the tracheation of the wings, a remarkable reduction of the wing-tracheæ having taken place. A similar reduction of the tracheæ of the wings exists in most families of Diptera; and even when a large proportion of the tracheæ are retained, as in certain Asilids, they afford little aid in the determining of the homologies of the wing-veins. For this reason we omitted a discussion of the tracheation of the wings of Diptera. Again, in the Hymenoptera we find that the courses of the tracheæ cannot be depended upon for determining the homologies of the wing-veins. But here, in the more generalized members of the order, we find a very complete system of wing-tracheæ; and it is, therefore, incumbent on us either to point out the correspondence between the tracheæ

[1] *American Naturalist*, vol. xxxii, April, 1898, p. 256.

and the wing-veins, or to demonstrate that such a correspondence does not exist.

In the introductory article of this series,[1] in discussing the figures of the wings of a nymph of Nemoura, we called attention to the fact that the tracheæ in the wings of that insect extend in straight lines or in gentle curves, while in some cases the corresponding veins are much more angular; and we offered the following explanation of this phenomenon:

It is evident from this that in the perfecting of a wing as an organ of flight the position of a vein in the adult may become quite different from that of the corresponding trachea of the immature form. In other words, although there is no doubt that the courses of the principal wing-veins of

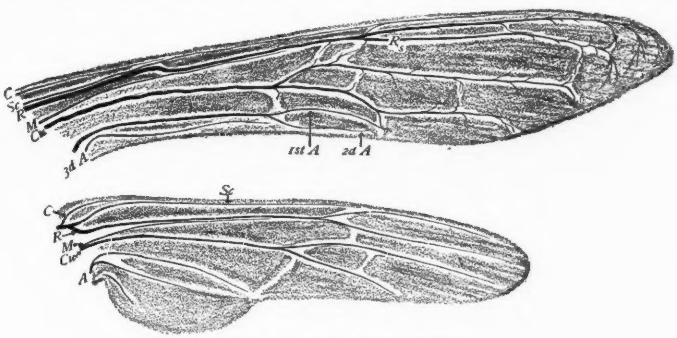


FIG. 46 — Wings of a pupa of Tremex.

primitive insects were determined by the position of the principal tracheæ of the wings, the wing-veins have been more or less modified to meet the needs of adult life; while at the same time the tracheæ of the immature wing, serving the purpose of respiration, and lying more or less free within the wing-sac, have not been forced to follow closely the changes in the cuticular thickenings of that sac.

In the Hymenoptera, as we have shown, the courses of the branches of the forked veins, in those forms where they have been preserved, have been so modified that these branches extend more or less transversely, making sharp angles with the main stems. It is not strange, therefore, that the tracheæ of the wings of the pupa lying free within the wing-sac, have not followed these changes.

[1] *American Naturalist*, vol. xxxii, January, 1898, p. 47.

Fig. 46 represents the wings of a pupa of Tremex; and Fig. 47, the fore wing of a pupa of Apis. In both cases the main tracheæ extend in nearly direct lines from the base of the wing to near its outer margin. This fact alone would indicate that the needs of respiration of the pupa, rather than the flight function of the adult wing, has been the important factor in determining the courses of these tracheæ.

A comparison of the fore wing of Tremex with that of Apis shows a remarkable difference in tracheation. In Tremex vein R_s is traversed by a branch of the radial trachea (R); while in Apis the radial trachea is not branched, and the trachea traversing vein R_s arises from the cubital trachea (Cu).

When this fact was first observed it was thought that the

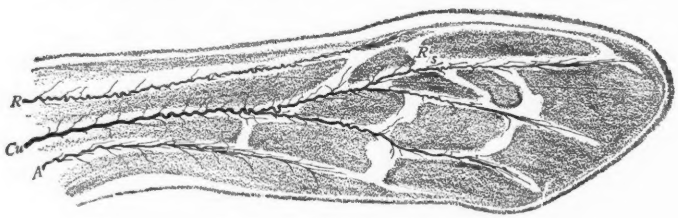


FIG. 47. — Fore wing of a pupa of Apis.

trachea of the radial sector in Apis had become transferred from the radial trachea to the cubital. We were not greatly surprised at this phenomenon, for a similar switching of tracheæ is common in those Lepidoptera in which the branches of the media become joined to the adjacent veins.

It was found, however, that this is not the explanation of the change. An examination of the wings of young pupæ of the honey-bee revealed the fact that in this insect the laying out of the wing venation precedes the tracheation of the wing. After the wing-veins reach that stage of development in which they appear as pale bands, the tracheæ grow out from the base of the wing into them. Fig. 48 represents the wings of a pupa taken at a stage which illustrates this pushing out of the tracheæ into the previously formed wing-veins.

It is obvious that tracheæ developed in this way will follow the paths offering the least resistance to their progress; and

that it is not to be expected that the tracheæ will preserve their primitive arrangement under these conditions. This brings us to the conclusion, already announced, that in determining the homologies of the wing-veins in the Hymenoptera we are forced to base our conclusions on a study of the veins themselves, and that a method of study which is of the highest importance in determining the homologies of the wing-veins in many other insects, is of little use here for this special purpose.

We have pointed out a striking difference in the tracheation

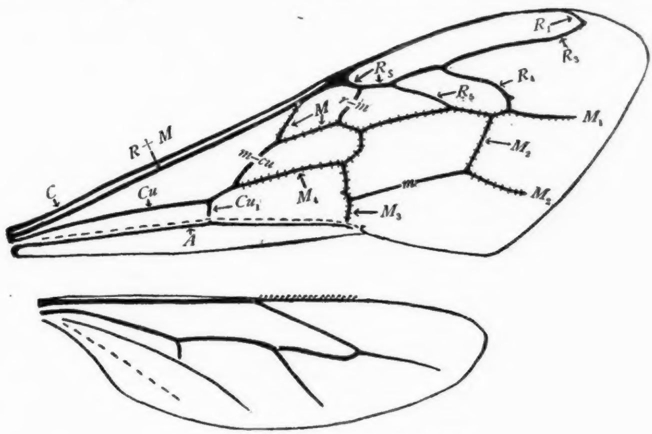


FIG. 48. — Wings of a young pupa of Apis.

of the fore wings of Tremex and of Apis. An equally striking difference may exist between the fore and hind wings of the same insect. Thus in the pupa of Tremex (Fig. 46) the main stem of the radial trachea traverses the subcosta in the fore wing; while in the hind wing it retains its primitive position. In more specialized members of the order, as in the Ichneumonflies, even less of the primitive arrangement of the tracheæ is preserved. But a further discussion of this phase of the question would not be profitable here.

XI. The Venation of the Wings of Embiidæ.

The systematic position of the family Embiidæ is a question regarding which there is much difference of opinion. We do

not purpose to discuss this question here beyond pointing out that in the structure of the wings there is little in common between these insects and the Blattidæ and Mantidæ, with which they have been associated by Brauer,[1] or with the Termitidæ or Psocidæ, with which they are grouped by Sharp.[2] If we were forced to decide regarding the rank of this family from a study of the wings alone, we would be obliged to regard it as representing a separate line of development of ordinal value. But in this place we wish merely to offer a suggestion regarding the probable homologies of the wing-veins.

Fig. 49 represents the fore wing of Oligotoma and is based on a figure by Wood-Mason.[3] If this figure is correct, there is little difficulty in recognizing the principal veins. The only

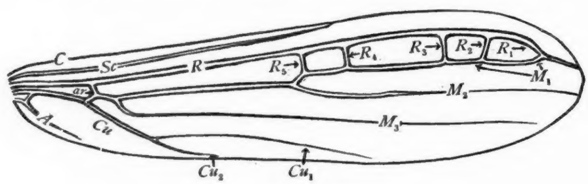


FIG. 49. — Wing of Oligotoma.

difficulty is presented by the four transverse veins on the distal half of the wing. After what we have seen in the wings of Diptera and of Hymenoptera, the most obvious interpretation of these is that they are branches of the radius, the tips of which coalesce with vein M_1. The result of this coalescence is that these veins have come to appear like cross-veins, as do veins R_4 and R_5 in the Hymenoptera. There is this striking difference, however: in the Hymenoptera only two branches of the radius bend back and unite with vein M_1; in the Embiidæ all of the branches of the radius are modified in this way. And in the Embiidæ there is no indication of a similar backward bending of the branches of the cubitus.

ENTOMOLOGICAL LABORATORY,
CORNELL UNIVERSITY, January, 1898.

[1] Friedrich Brauer, *Systematische-zoologische Studien*, p. 126.
[2] *The Cambridge Natural History*, vol. v, p. 342.
[3] *Proc. Zoöl. Soc. London*, 1883, p. 628.

ON THE CLASSIFICATION OF CILIATE INFUSORIA.

DR. V. STERKI.

AFTER so eminent a naturalist as Bütschli has modified Stein's system of Ciliata, it may appear rather assuming if I venture to propose some changes. It is done because my views have long been held, and have been confirmed as the years passed.

In the first place, it seems that the Peritricha are of an organization quite different from that of all other ciliates. The formation of the anterior part, peristome, mouth, etc., is unique, although having some resemblance to that of the Stentorina. There is no adoral zone with transverse rows of cilia like that in Heterotricha and Hypotricha, as has recently again been asserted by Delage et Herouard.[1] The arrangement of the muscular elements in the ectoplasm, or myonems, is quite different. The formation of a temporary posterior girdle of cilia for locomotion, in the most typical Peritricha, and even the permanent one in some others, is a very distinguishing feature. And a distinction of highest order is their mode of fission in the longitudinal axis,[2] or by gemmation. This character has been explained in various ways, and some have tried to bring it in conformity with the transverse fission in the other groups. Nevertheless, it remains different, and shows, combined with the other features noted above, that this group is of quite another type, or phylum, the more so if we add the peculiar phenomena of conjugation. The remaining Ciliata differ from the Peritricha in regard to these characters, and they resemble one another in respect to the most significant of them.

[1] *Traité de Zoologie Concrète. I. La Cellule et les Protozoaires.* Paris, 1896, p. 452.

[2] It must be noted, however, that in all groups the direction of the division is across that of the myonems.

In opposition to the Peritricha, we may give to this second group the name Pantotricha. Among the latter, those forms having a true adoral zone with a distinct beginning and end at the mouth entrance, and bearing transverse rows of single cilia, that is, the Hypotricha and most of the Heterotricha, evidently are of a common type, and range in one group, which I propose to name Zonotricha. True, the extreme forms are very different, *e.g.*, a Stentor on the one hand, and a Stylonychia or Euplotes on the other. But it is well known that both series, by gradual changes, in fact, run together, and that there are forms which may be ranged with one or the other. Many Peritricha are quite depressed, while there are Oxytrichidæ nearly terete, showing little differentiation of the dorsal and ventral faces, with fine and densely set cilia over most of the body (Strongylidium). And such forms as Stichospira[1] make the distinction still more illusory. Tactile hairs (or "dorsal cilia") are wanting in some of the Oxytrichidæ as well as in Euplotidæ and Aspidiscidæ. Longitudinal differentiation in the ectoplasm of Urostyla, etc., comes very near the myonems in Peritricha. With the Zonotricha range Halteria, probably also Strombidium and Gyrocoris. A rather aberrant group, falling under the same head, are the Ophryoscolecidæ, with their retractile peristome.

After removing these forms, the Oligotricha, *i.e.*, mainly the Tintinnidina, make a more uniform small group, characterized by the circular uninterrupted zone bearing cilia of a different form and type, inside of which the mouth is situated.

The Gymnostomata have been made by Bütschli a group of highest order, equal in value with all the other groups combined. It has been shown above that in a number of essential features they differ from the Peritricha and are in harmony with the other Pantotricha, and they are especially so with the Aspirotricha. Yet the formation of the mouth, together with some other characters, is so significant that it does not seem natural to reunite these two groups into the old order Holotrichida, as the French authors have done (*loc. cit.*, pp. 430, 452).

[1] See the writer's article, this journal, vol. xxxi, No. 366, June, 1897, pp. 535-541.

In the great diversity of the formation of the body among the Gymnostomata we have an interesting analogue with an equally wide range among the Zonotricha.

The highest position must be assigned the Oxytrichidæ and Euplotidæ. Here the differentiation of the main feature of the ciliates, the cilia, reaches its maximum, not only morphologically, but also physiologically, combined with the highest development of intellectual faculties, as far as we dare speak of such. In all these points the Peritricha, which have often been placed at the head of the class, are inferior. And their inferiority is demonstrated also by the fact that at least half of them are epizoa, or commensals ; a large number of animals of both categories live in colonies, either actually coherent or close together, modes of life which are not so much different as is commonly supposed.

The groups Peritricha,[1] Gymnostomata, Aspirotricha, Oligotricha, and Zonotricha seem to have the significance of orders of about equal standing with "orders" throughout the animal kingdom. Thus we would have the following table :

Subclasses	Superorders	Orders
Peritricha		Peritricha
Pantotricha	Gymnostomata	Gymnostomata
	Trichostomata (em.)	Aspirotricha
		Oligotricha (em.)
		Zonotricha

The Ciliata here are regarded as a class. To this point, a little digression may be excused. Why should not both Ciliata and Suctoria be treated as classes? Conceded that Bütschli is right in regarding the tentacles as mouths, and I believe so, that would not necessitate ranging them together. The possession of cilia by the Acinetina, in the early stages of development, has possibly been overestimated. How many features are shown, in the earlier or larval stages of other and higher animals, to disappear at a later period, *e.g.*, cilia in Mollusca (velum) and Echinodermata? If an amœboid stage, or the development and disappearance of flagella, were accorded so

[1] The Peritricha might probably be divided into two orders; but, since I have not seen Licnophora and Kentrochona, the question is left open here.

much significance, how should we then, with good reasons, regard the Rhizopoda, Sporozoa, and Flagellata as so many classes? The close resemblance of the phenomena of conjugation in the Ciliata and Suctoria are certainly significant ; but we have essentially identical ways of fecundation, etc., of the ova in different main groups of Metazoa. In their definite formations the Ciliata and Suctoria are as much different from each other, or much more so, than, for example, the classes of vertebrates and arthropods. The question seems to be rather one of logic : if the Suctoria, in their definite stage, are to be considered a degenerated type of Ciliata, they must be ranged under the same head, as a subgroup ; if not so, they may well rank as a class at the side of the Ciliata.

NEW PHILADELPHIA, OHIO,
April, 1898.

EDITORIALS.

A War of Extermination. — The Second Annual Report of the New York Zoölogical Society contains a graphic and startling report on an inquiry into the destruction of our native birds and mammals, made by Mr. W. T. Hornaday, the Director of the Society's Park. Observers in every state and territory were asked whether a decrease of these animals was noticeable in their locality, and, if so, what the causes were and which species were most affected. From nearly two hundred replies the conclusion is drawn that, in the thirty states reporting a decrease, there is a diminution in the number of birds, as compared with fifteen years ago, of fifty per cent. The results concerning mammals are equally startling, and the list of the better-known mammals on the verge of extinction includes seventeen species. The replies indicate that sportsmen, boys who shoot and who collect eggs, market hunters, and milliner's hunters are chiefly to blame. The most outrageous perversion of the sportsmen's instinct is seen in the atrocious "side hunts," in which a graded count is put on all the different kinds of birds and mammals killed, such as squirrels, chipmunks, chipping sparrows, nuthatches, blue jays, and woodpeckers. In one of these "side hunts" forty adult men secured in a few hours 212 gray squirrels, 210 red squirrels, 56 partridges, 25 blue jays, 41 woodpeckers, 6 owls, and so on; altogether 565 active, beautiful wild animals slaughtered in one day in one locality to make counts! Truly there is only one other mammal with which such men can be compared, and that is the tiger, which kills not for food, but for the love of killing. This is an evil which must be cured at once, or the remedy will be applied too late. Societies, sportsmen's clubs, and legislatures are beginning to make feeble attempts at control; but a more thoroughgoing, far-reaching organization is necessary to secure uniform action throughout all the states regulating the destruction of wild animals and providing for an enforcement of the laws. In the absence of such legislation, circulars cannot be relied on to influence "sportsmen" so thoughtless of the practical needs of agriculture as well as the equally important esthetic needs of human beings who love nature. Personal influence must be exerted everywhere by friends of the cause to save the remnant of our mammalian and avian fauna. As a campaign document get the Report from Mr. Hornaday, 69 Wall Street, New York City.

Zoölogy in Japan. — The completion of the first volume of the *Annotationes Zoologicæ Japonenses* enables us to see clearly the present direction of zoölogical science in that country. As is to be expected, systematic work predominates, and, naturally, the first duty of the Japanese to the science lies in this line. It is interesting, however, that marine invertebrates are more the objects of attention than those of the land, instead of less, as in European countries. This reveals the morphological training of those who are conducting or guiding investigations. Embryology is represented by Nishikawa's study on the migration of the eye in a flatfish, Ikeda's study on the development of Rhacophorus, and Hatta's on the Pronephros. Cytology is represented by Aida on the growth of the ovum in Chætognaths. In experimental work we have Yasuda's studies on accommodation of Infusoria to dense solutions.

The Diagnostic Characters of Birds. — *Apropos* of the letter of "Zoölogist" in the March number of the *American Naturalist*, Mr. Frederic A. Lucas calls our attention to a passage in his paper on the Cœrebidæ.[1]

After speaking of the difficulty of determining the affinities of this group, he goes on to say: "Of course our trouble lies in the fact that the so-called families of Passeres, at least very many of them, are not families at all, or not the equivalents of the families of other groups of vertebrates. It is my belief that any group of vertebrates to be of family rank should be capable of skeletal diagnosis, and this test applied to the Passeres reduces them to a family or two, as has been done by Huxley and Fürbinger."

In his letter Mr. Lucas says that "for family one may equally well read genus. The groups of birds are nearly all pitched on too high a key, the orders being families (to a great extent), families, genera," etc.

[1] F. A. Lucas, Notes on the Anatomy and Affinities of the Cœrebidæ and other American Birds, *Proc. U. S. Nat. Mus.*, vol. xvii, No. 1001, pp. 299–312, 1894.

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

A Study of Hawaiian Skulls.[1] — The collection studied contains sixty-five crania. One series is from the lava caves and represents the dominant race of the Hawaiian Islands, and the other is from the sands of the coast where the common people were buried. Dr. Allen states that it is impossible to say to what extent the differences between the two series are due to differences of caste, and how much is due to the fact that the coast series is more recent than that from the caves, and has been more affected by imported diseases. The number of skulls in each group is comparatively small, so that on the whole the differences shown are of doubtful importance. The value of the paper lies in the methods employed rather than in the contrasts shown between the two types of crania. The descriptive method is given much less prominence in this study than in the author's memoir on the Crania from the mounds of Florida. It is stated in the preface that the method by measurements, "all things considered," is the most fruitful. The differences in anatomical variation are expressed in percentages rather than by perplexing Greek compounds.

A few of the dimensions are charted on quadrille paper by the "terrace" method of graphic delineation, an innovation in craniometry. The advantages of broken over curved lines are obvious. We believe that other devices in common use by statisticians might be employed with advantage by craniologists, *e.g.*, the average, minimum, maximum, and relative amount of variation may be clearly and easily shown by simple bar diagrams. Craniology concerns itself largely with the study of variation, and the numerical expression of this, while precise, conveys little meaning to the uninitiated.

Dr. Allen's paper emphasizes the fact that there are other problems than those of race for the consideration of the craniologist — in the closing words of the author: "I remain of the opinion that the interest attached to the study of the human skull is not confined to attempting to limit race, but to the study of the effects of nutritive and even morbid processes upon the skull form."

[1] Harrison Allen, A Study of Hawaiian Skulls. *Trans. of the Wagner Free Inst. of Sci.* Philadelphia, 1898.

The Winter Solstice Ceremony at Walpi.[1] — In his address before Section H at the Detroit Meeting of the American Association for the Advancement of Science, Dr. Washington Matthews said: "I believe, as a result of an extensive experience, that ceremony offers material for the study of human development equal to that offered by art, government, legend, or any other subject of ethnologic investigation" (*Journ. Am. Folk-Lore*, vol. x, p. 258). This material is being utilized by an increasing number of ethnologists, among whom Dr. Fewkes is one of the most active workers.

"The two solstices are marked epochs in the ritualistic life of the Tusayan Indians," but the ceremonies observed at the Winter Solstice are the more important. The account of these ceremonies, witnessed at two of the five villages practicing them, is given in detail. The author states that the ritual is the result of growth by composition and mutual reaction, and that it will prove to be "particularly instructive to the student of the migrations of the ancient peoples of Arizona, especially those of the Sun and Rain Cloud clans, which, it is claimed, came to Tusayan from the far south."

The value of the paper is enhanced by the addition of a bibliography of the extensive literature by the author upon the elaborate "ceremoniology" of the Tusayan pueblos.

F. R.

GENERAL BIOLOGY.

Regressive Evolution in Biology and Sociology.[2] — The well-known authors associated in this work contribute special knowledge in their respective departments, with the aim of elucidating especially the phenomena of vestiges in sociology from the facts of biology. Between the sciences of facts, indeed, a marked parallelism can be traced.

The work considers first regressive evolution generally, and the conclusion is drawn that all transformations of organs and institutions are accompanied by regression, and that, since all the higher organisms contain reduced organs, and all social institutions contain survivals, regressive evolution is universal.

Regression does not proceed backward along the same path as

[1] J. Walter Fewkes, *American Anthropologist*, vol. xi, p. 38.

[2] J. Demoor, J. Massart, et É. Vandervelde, *L'Évolution regressive en biologie et en sociologie.* Paris, Alcan, 1897, 324 pp.

that which development had pursued; also, it is not reversible — that is, an organ once lost cannot reappear, nor can a degenerate remnant again fully develop.

Regressive evolution is caused by the limitation of the means of subsistence — food, capital, or forces for work. In biology it has for its principal if not its only factors, the struggle for existence between the organs and the struggle for existence between the organisms. In sociology artificial selection plays a preponderating rôle, natural selection a secondary one. The occasional causes of regressive evolution are inutility of function, the insufficience of nutrition or of resources, and, in biology alone, the lack of room. An institution or an organ which has ceased to be functional and has lost all utility, direct or indirect, persists, however, if one or other of the factors of atrophy, variability, or selection is not at work.

The book is written in an interesting, somewhat popular style, and is illustrated by numerous figures in the text.

ZOÖLOGY.

The Mammals of Florida.[1] — In Mr. Bangs's recent account of the mammals of peninsular Florida and the coast region of Georgia we have the first attempt at an exhaustive enumeration of the mammals of a definite geographical area from what may be termed the point of view of the new era in the history of North American mammalogy. It therefore gives a good opportunity of contrasting the new with the old in this field of research. Of papers based on large collections of mammals from restricted areas, and also of monographic reviews of particular groups, there has been no lack in recent years, but none has before attempted to treat exhaustively the mammalian fauna of a well-defined and considerable area.

It is needless to say that Mr. Bangs approaches his subject from the radical point of view of the "new school," and it is therefore of interest to contrast our knowledge of to-day, as here reflected, of the mammalian fauna of Florida with that of, say, twenty years ago. Fortunately, Mr. Bangs's "Comparative Table" of the principal previous lists of the mammals of the region under review renders

[1] Outram Bangs, The Land Mammals of Peninsular Florida and the Coast Region of Georgia, *Proc. Boston Soc. Nat. Hist.*, vol. xxviii, No. 7, March, 1898, pp. 157–235, with text cuts.

such comparison easy. Up to 1883 (1871–83) only 35 species were recognized from the region in question; this number is now raised by Mr. Bangs (including numerous subspecies) to 73. Five of these, however, are from the coast region of Georgia, only 68 being enumerated as Floridian.

"The coastal strip of Georgia and northern, central, and southwestern Florida agrees very closely in general conformation, and also in faunal and floral characters." The general surface of the country is "flat and monotonous, with a light sandy soil and interminable forests of pine." The coast region of Georgia and northeastern Florida, south to Matañzas River, "is one continuous stretch of salt tide-marsh interlaced by deep creeks, and now and then broken by a sandy beach where some higher point of land meets the deep water." Along this coast is a series of islands, some of the larger of which, as Cumberland Island, Georgia, and Anastasia Island, Florida, and some of the Florida Keys, though separated so slightly from the mainland, appear to have developed a number of well-marked insular forms, the discovery of which has done much to increase the list of species now recognized from the general region. But aside from this, peninsular Florida, which is subinsular in position and environment, has furnished in recent years not only many new species and subspecies, but some forms so distinct from any previously known as to fairly entitle them to rank as new subgenera. The increase in the list of recognized forms is thus only in part due to the fine discriminations it is possible to make by aid of the greatly increased and vastly better condition of the material now available for study, as compared with even a decade ago, but to the thorough exploration of what appears now to have been, up to within a very few years, a very imperfectly known region, mammalogically speaking.

But this was not only the case with Florida, but with North America at large, not excluding even the long-settled parts of the eastern states. Most of the smaller mammals are chiefly nocturnal and more or less subterranean in their habits, and formerly, even as late as fifteen years ago, their capture was largely a matter of accident, and series of specimens of any but the most common species did not exist. Then, too, their preparation was so faulty as to greatly impair their value for study, and measurements taken from the animals "in the flesh," or before skinning, were rarely available. But of late all this has been changed; the trapping and preparation of small mammals have been reduced to a science, so that certain kinds of mammals it was formerly thought almost impossible to

capture, from their supposed rarity or obscure habits, can now be had in any desired numbers with a certainty and ease not dreamed of in earlier days. To this change in resources is due the recent great advance in our knowledge of North American mammals, of which Mr. Bangs's report on Floridian mammals may be taken as a fair index.

Among the more notable recent additions to the known mammalian fauna of Florida may be mentioned the large water vole, described by Mr. True in 1884 as *Neofiber alleni*, it being then considered as the type of a new genus, but now referred as a subgenus to *Microtus* (formerly *Arvicola*). Although known for several years from only two or three specimens, it was taken in considerable numbers in eastern Florida in 1889 by Mr. Chapman, who was the first to make known its interesting life history,[1] and to whose paper Mr. Bangs fails to make reference in his extended comment on the species. In view of its present known wide distribution in eastern and interior Florida, its comparatively large size and easily recognized presence, the late discovery of this species, as remarked by Mr. Bangs, is one of the strangest facts in the history of American zoölogy.

Another almost equally interesting discovery is that of the big-eared Florida deer-mouse (*Peromyscus floridanus*), described in 1889 by Mr. Chapman from a single immature specimen, and redescribed in 1890 from an adult individual by Dr. Merriam. This is the largest and biggest-eared deer-mouse of Eastern North America, and though known for some years from only two or three specimens, it has since been found to be a common species over a considerable area, and is now well represented in collections of Florida mammals.

Almost equally interesting is the white-bellied Florida deer-mouse (*Peromyscus niveiventris*), described also by Mr. Chapman in 1889, this being as much smaller than previously known deer-mice from Eastern North America as the big-eared species just mentioned was larger. It is also otherwise peculiar, and proves to belong to a group restricted to Florida, of which three species and two additional subspecies are now recognized by Mr. Bangs, one of them being insular (*P. phasma* Bangs, Anastasia Island).

There are numerous other forms worthy of note, but space will suffice only to say that to the 35 species known from this area prior to 1884, 38 species and subspecies have been added since that date, 30 of which have been described as new, all but two within the last ten years, including 16 described by Mr. Bangs in the present paper.

[1] *Bull. Am. Mus. Nat. Hist.*, vol. ii, June, 1889, pp. 120–122.

Eight species previously described, but not then known from Florida, complete the 38 additions, more than doubling the list. The names of 12 others have been changed through the recognition of the Florida phase of wide-ranging species as subspecifically distinct from the species formerly recorded as Floridian, so that the total number of new forms from Florida and the coast region of Georgia described, with two exceptions since 1888, is 42, out of a total of 73. Excepting among the bats, nearly all of the old species have been split into one or more subspecies, while the representatives of some of the genera have greatly increased. For example, *Geomys* (pocket gophers or "salamanders") has increased from 1 species to 4, with an additional subspecies ; *Peromyscus* (deer-mice), from 3 species to 8 species and 3 additional subspecies.

Some of the subspecies recognized by Mr. Bangs are only very slightly differentiated local forms, so slightly that the advisability of their recognition in nomenclature is, to say the least, in some instances doubtful.

Mr. Bangs's paper is an important contribution to North American mammalogy, and is of especial value as a contribution to the faunal literature of a peculiarly instructive and interesting region.

J. A. A.

Frog Biography. — That most useful animal, the frog, has been so thoroughly discussed in such works as those of Ecker, Marshall, and Morgan, that it might seem at first sight as if there were nothing more to be said beyond the completion of anatomical and embryological details.

The first of a series of natural history notes [1] made upon Amphibia by H. Fischer-Sigwart, presents so much of interest in the life history of the frog, *Rana fusca*, that we wait eagerly for more, and, at the same time, venture to hope that some American representative of this group may soon meet with as sympathetic a biographer.

The author's observations extend over a period of some thirty years ; the past ten years furnishing continuous data of times and seasons and measurements, made in the field and in his "terrarium," and now collected in tables. These and the double-page plate (the artistic merit of which must be seen to be appreciated) may be passed by to begin a brief synopsis of some of the facts recorded.

Scattered over the country, far from the water, the frogs of this species pass the summer in feeding, being most active by night and

[1] *Vierteljahrsschrift d. Naturfor. Gesell. in Zürich*, January, 1898, pp. 238–313.

lying concealed by day. After the middle of summer their appetites grow less keen, and as autumn comes on they begin to leave the special hunting fields that each has held for itself, and to migrate, singly, toward the ponds and lakes. It is, however, only the sexually mature animals, four or five or more years of age, that thus migrate; the young ones remain. The adults pass the winter concealed about the shores or in the mud at the bottom of the ponds, and awake from the dormant state when the early spring thaws out the ice. This occurs in March or February in the lowlands, but high in the mountains perhaps not until the middle of summer.

The awakened frogs congregate in great numbers and fall an easy prey to the greatest of all their numerous enemies, man; before they were decimated by wholesale slaughter at this, their breeding season, a single fisherman might take 1500 frogs in a single day.

The males, which we infer are much more numerous than the females, clasp the females and passively suffer themselves to be carried about in the water, or even upon land, for several days — three to thirty, in different places and seasons. Whether the males use their vocal organs to produce their "purring" noise or not seems to depend upon the temperature, and their use in warm weather indicates, the author thinks, a cat-like state of content. In cold seasons these sounds may not be heard, though breeding continues as usual.

The actual spawning is accompanied by a maximum of excitement when the females, covered by a struggling mass of males, sink to the bottom of the ponds and there deposit their eggs. Each egg is 1½ to 2 mm. in diameter, black above and white below, and enveloped in a lump of jelly 4 mm. in diameter. The eggs deposited by a female form a cluster about as large as a hen's egg, and these clusters stick together so that a gelatinous layer may be formed on the bottom of the pond, extending, in some cases, as a band a meter wide all along the shore.

This breeding season lasts on the average 134 days, from the first awakening to the completion of spawning, and during that time the frogs take no food — unless, sometimes, their skins! The skin comes off in shreds, in the water, at this season, and is shed again three times during the year. In these moltings the animal may eat its own skin.

When the eggs are laid and fertilized, the frogs all leave the ponds suddenly in a single night and gradually return to summer hunting grounds far from the water.

The gelatinous masses left on the bottom of ponds swell and rise to the surface after a few days, and later sink 20 to 30 cm., where they hang suspended. From the size attained by the jelly-capsule surrounding each egg one may judge of the length of time the eggs have been laid. The eggs hatch after 6 to 19 days (about 10½ days in the terrarium, and 12½ to 13½ in the ponds outside). The larvæ form a jet-black mass on the egg-jelly, and then swarm about over it, and in two or three days scatter and hang attached by their adhesive organs to floating leaves and to plants. After a week their external gills are gone, and they have taken on the well-known "tadpole" proportions. The jelly floats about and dissolves away.

The tadpoles develop their hind legs in 55 to 60 days after hatching, when 38 to 44 mm. long; and both fore legs when 70 mm. long. They eat anything that is soft, chiefly decaying vegetable matter; are very fond of putrid veal, and thrive well on earthworms in a similar state. After 79 to 81 days, when 45 to 50 mm. long, the tadpoles transform into small frogs.[1]

These young frogs all leave the water immediately, and after a few days move away from the shores of the ponds to scatter abroad, each settling in some separate hunting ground, there to remain four years or more, till sexual maturity calls them back to their native pond.

At the first the young frogs are 15 to 20 mm. long; they grow to be 25 mm. long the first season, 30 mm. the second year, 50 to 55 mm. the third, 60 mm. or more the fourth, and 70 to 80 mm. the fifth, when they are sexually mature.

Kept in captivity they soon grow fat and dull (*i.e.*, tame), and furnish to careful observation some facts of interest to comparative psychologists, though it cannot be said that they give much evidence of high psychic activity.

Later, when these snakes were removed, the frogs no longer exhibited alarm at a stick. This snake seems to hypnotize the frogs so that they make no resistance but allow themselves to be swallowed, while they will flee from some other snakes. They seem also to recognize this enemy by its odor, if we accept the author's evidence.

They learned to come to a certain place to be fed at a certain time, and, after wandering about in the night time, came regularly back to some habitual resting place to spend the day.

They fed most voraciously, eating even hornets without great

[1] In one case all the eggs of a bunch were white and produced albino tadpoles, with dark eyes, however; but these became brown and changed into frogs but little lighter than normal.

inconvenience, and using their hands to force the ends of large earthworms into their mouths. They could be made to take meat and even carrion held on a needle before them. In this way the captive frogs were made much more fat and larger than those of the same ages outside.

Such overfed creatures developed a second period of sexual excitement in midsummer, but this led merely to certain males grasping the females for a short period.

Observations made in the neighborhood of Zofingen, Switzerland, and upon a frog not found here, may have no direct bearing upon the life history of our own frogs, but they indicate lines for imitation. With increasing interest in aquaria and gardens, both botanical and zoölogical, we may hope for more natural history work of this kind, and for the filling up of immense gaps in our knowledge concerning the length of life and rate of growth of animals.

E. A. A.

Psychical Qualities of Ants and Bees.[1] — The question as to whether or not we may ascribe psychical qualities to ants and bees is discussed by Albrecht Bethe in a recent issue of *Pflüger's Archiv.*

In his introduction the author points out the danger of an investigator's personality being read into the subject investigated, and also danger of the use of such words as carry with them meanings not warranted by the facts; men see, but all we know about bees is that they are influenced by light, and it would be unscientific to say they do anything so highly psychical as seeing until it is proved. It is absolutely impossible to find words which are always consistent with this idea, but the endeavor has been made to do so as far as possible.

The polymorphic colonies of bees and ants are pointed out as giving direct evidence against the Lamarckian principle of the inheritance of acquired characters. This polymorphism, Bethe believes, is completely explained through congenital diversity and natural selection, as is true also for all purposeful reflexes.

It is well in reading the paper to bear in mind the author's distinction between reflexes and instincts. "Only those actions can be designated instinctive in which an animal, which can be proved to possess psychical qualities, follows an inherited impulse without a

[1] Albrecht Bethe, Dürfen wir den Ameisen und Bienen psychische Qualitäten zuschreiben? *Archiv f. d. Ges. Phys.*, vol. lxx, Pts. i, ii, pp. 15–100, January, 1898.

previous process of learning, in which the action is not purely reflex, but is eventually regulated through psychical processes"; "sexual intercourse is instinctive in man, but is a reflex in beetles. A silkworm spins its cocoon reflexly, but a bird builds its nest instinctively. Instincts are neither wholly reflex nor wholly psychic."

Individual diversity extends farther than is generally supposed; even the odors given off by individuals are characteristic, since through them bloodhounds are able to follow one trail unerringly.

The first one of the two main divisions of the paper is devoted to a research on ants, and the first question asked is:

"Do ants of one colony recognize each other?"

From the fact that an ant, if placed on a nest (not its own) of either the same or a different species, will be seized and often killed, it has been concluded that they know each other personally and distinguish between strangers and their own number, although some nests contain thousands of individuals.

Lubbock investigated this subject and found that:

1. After a separation of almost two years, individuals of *Fomica fusca* were received in a friendly manner when placed back on their own nest.

2. Pupæ, separated from their nest but cared for by workers from it, were received in a friendly manner without exception if placed back when grown.

3. If pupæ were cared for by workers of another nest, it was different. Out of forty-four placed on their own nest, seven were attacked and thirty-seven received. Of fifteen placed on the foster worker's nest, all were attacked.

4. An egg-laying queen was taken from her nest, and her subsequent brood when grown was not seized when placed on the nest. These results led Lubbock to believe that there is no personal recognition among ants of one nest; and from the fact that chloroformed ants were received by their own fellows but seized by individuals of a strange nest, he concluded that reception or rejection did not depend upon any sign or word, but what was at the bottom of the matter he did not understand.

Romanes thought their methods of distinguishing each other were not capable of being understood by us, but that it was, through some kind of psychical process, a species of memory.

McCook, observing that after an ant had fallen into water it was attacked when coming home, concluded that through the bath the ant had lost its peculiar odor, hence was no longer recognized.

Forel found that ants of different nests could be brought together without one seizing the other, provided the antennæ be first removed. He held that the sense of smell was located in the antennæ, and that it is through this sense that ants of the same nest are recognized.

But unless it had been shown that each ant learns in its individual life to answer the smell of its own nest fellows in a friendly, and that of strange ants in an unfriendly, manner, and that it does not do this *ab-ovo*, it is not proved that we are dealing with "knowledge" or "thought."

An ant smeared with an extract of the bodies of its own nest fellows is received when placed on its own nest, but seized if smeared with an extract of strange ants. This was tried in several cases and held true in each.

An ant if first bathed in 30% alcohol, then with water, then smeared with the extract of another species, will be received by the colony from which the extract is made. From the fact that the strange ant may be many times larger than those among which it is introduced and of a different color, it is proved that *form* or *color* plays no rôle, but as the presence of a strange ant disturbs them when several millimeters away, it would appear that a volatile chemical material is concerned in the different reaction of ants toward their fellows or toward strangers. If the ant be washed with 30% alcohol and water, and as soon as dry returned to the colony, it will be seized, but if kept away twenty-four hours and then returned, the colony will receive it. From this and Lubbock's experiments it is shown that this volatile material, which is called "Neststoff," is alike for individuals of the same nest, and every nest has its characteristic "nest material," which is produced by each individual.

Young ants, of a *Lasius nigra* nest, which had never met a stranger, were allowed to mature and harden in a box, then some were placed on a nest of Tetramoria, which were thrown into the greatest unquiet; some were placed on their own nest, where they ran quietly among their nest fellows. A few Tetramoria were placed in the box with the remaining ants, and the Tetramoria were at once attacked. Nothing here had been learned but that the different reactions toward like and unlike "nest materials" are inherited. Like material (that produced by ants of the same nest) constitutes no stimulus, but unlike "nest material" calls forth a reflex of either fighting or fleeing, depending on the amount present.

Ants, if confined in a gauze box on their own nest, will not be noticed but allowed to starve. Ants of another nest placed in the

same box will call out the fighting reflex of dozens, which soon surround it, endeavoring to get in. The relative amounts of the two "nest materials" seem to determine the reflex. The actions usually explained through "love," "compassion," or "hate" are better explained on purely physiological grounds.

In pupæ the "nest material" is not yet differentiated, for all pupæ will be eagerly accepted by all ants. As the pupæ grow, their "nest material" mixes with that of the foster colony and the whole is modified. A colony of more than one species is thus formed, examples of which are found in slave-making ants. The slaves of a nest will not be received if placed in the nest from which taken. They do not know their masters, nor do the masters know the slaves. They have become one colony through the mixing of their "nest materials."

From the foregoing it appears that the different reactions of ants toward individuals of their own and different nests depend on reflexes.

The next question that the author considers is:

"How do ants find their way?"

It is generally thought that ants know the region about the nest, and orient themselves when going about by familiar objects, either through sight or smell. They travel on paths, and when off the path are lost until it is regained. Some sugar was placed on a blackened paper in front of a nest. The first foraging ant did not find the sugar; the second ant, after making many curves, zigzags, and loops, found the sugar, took a grain and retraced its steps, but cut off the loops. Before it had reached home a third ant had come to the place on the paper where No. 2 had left it, followed its track to the sugar, and returned the same way; and all ants which came near this path followed, each straightening it, however, by an antenna's length, until in an hour or two there was a straight path between the nest and the sugar. None followed the unsuccessful trail. It would appear from this that not only is a track left which may serve as a guide to other ants, but which is of such a nature as to indicate the outcome of the expedition. The paths were followed as well when covered with black paper tunnels as if left well lighted, but a strip of paper 5–10 mm. wide laid flat across a path would bother the ants greatly. They would stop on reaching the paper, become very unquiet, several would collect on both sides, but none would cross over; some would turn and go back, some try to crawl under the paper. Something is deposited on the path which guides them, the volatile nature of which is shown by the fact that if the strip of paper is allowed to remain

until the path is well established across it and then removed, the space from which it was taken becomes as great a hindrance as the paper when first laid down. The drawing of the finger across a path leading over a glass plate will cause the same result as the paper strip. In the first case the guiding material is covered up, in the second it has passed off naturally, while in the last it has been wiped away.

Loaded ants, even if picked up, rotated, and placed on the path backward, always go toward the nest. A path was led across a board, a section of which could be reversed, thus making a part of the path lead in the opposite direction from which laid down. When reversed, the next ant on coming to the section from either direction would stop, flourish its antennæ over the path, run first to one side and then the other, but would not proceed. If the section was not reversed until the ant was on it, the ant would continue on its way across the section, but on coming to the place where the section ended, instead of going on it would act as described above. These and other similar experiments leave little doubt that there is a polarization of the guiding material; but to say it is polarized does not explain all phenomena. Unless the ants walked home backward or deposited the material backward while coming home, there would be nothing present to indicate the direction of the nest. One experiment showed, however, that outgoing ants follow the paths of incoming ants with difficulty, and *vice versa*. This indicates the existence of two different guiding materials in the same path, one an incoming guiding material, the other deposited by outgoing ants.

Lubbock thought that he had proved that ants communicate with one another, but Bethe uses one of Lubbock's own experiments to show that it proves nothing. If a handful of pupæ placed on a piece of paper near the nest be found by an ant, soon numbers of ants will be carrying the pupæ home; but if an ant be carried to the pupæ and when it has taken one, it be aided to find its way home and so on for several trips, using the same ant each time, no other ants ever find the pupæ. In the latter case no path is laid down *to* the pupæ, hence there is nothing to guide the ants to them, while in the former experiment they had a path to guide them. All of Bethe's experiments to ascertain the presence of any communication between ants could as well be explained through simple physiological stimuli as through intelligence.

Several experiments, calculated to call out the intelligent action of ants, should they possess such even in the most meager degree, were carried on, but all with negative results.

The second half of the paper is devoted to a research on bees. Do bees of one hive recognize one another?

Bethe finds that they, like ants, do not know individuals either by sight or smell, but that, *ab-ovo*, they react in a friendly manner toward their own colony "nest material," and in an unfriendly manner toward a "nest material" of bees of other hives. As with ants, two "nest materials" may be so mixed as to become one, as is shown by the method necessary in introducing a new queen into a queenless colony. If unprotected she is at once killed. If, however, she is put among them for a few days, protected by a gauze box, and then liberated, she is received. At first her "nest material" calls out the fighting reflex of the hive, but given time the "nest materials" of both mix and cease to afford any adverse stimulus. That the difference in the "nest materials" of two hives is produced by congenital diversity is shown by the following.

A hive was divided, half the grubs of the old being given to the new hive. In a few days, when these young bees had come out, some were taken from the old hive to the new, and were treated as belonging to the new hive. For two or three weeks bees of one hive could be placed in the other and be well received, but after this time the brood of the new queen began to come out. One of these new bees introduced into the old hive would be killed, and bees from the old hive would be attacked by the new brood of the new hive. Old bees of the new hive if isolated twenty-four hours were still received by the old hive, but after three weeks longer no more mixing of the two hives could be effected. The "nest material" from the new queen had become strong enough to modify that of the whole hive.

How do bees find their way?

They could not leave a material in the air, as is left by ants on their paths, which could guide them to and from the hive, but since a male moth has been known to locate a female several miles distant, it seemed possible that still a volatile chemical material might be the agent which guides bees. A tunnel of paper placed over the entrance to the hive caused a great change in the actions of the bees; few crossed over the paper either in or out, but collected at the edge, both on the inside and outside of the tunnel, and buzzed. When it was removed there was a gush of bees, both entering and leaving the hive. A bridge of paper over the entrance caused no such disturbance, since the entrance board was left free, on which there was a material which guided the crawling bees.

If *flying* bees are guided by the "nest material" which is radiating

from the hive, then turning the hive 90° should have had no effect; but it did. The bees returned to the side where the entrance was before the turning. Thinking that the rapid turning might not have been followed by the dense cloud of "nest material" which exists immediately before the entrance, a hive was mounted on a horizontal wheel, and the whole on a truck, so that the hive could not only be turned slowly, but moved from one place to another.

When a revolution of 90° was made in fifteen minutes, the bees went in well until the 30° point was reached, after which fewer and fewer went in, until at 90° none entered the hive at all. When twenty minutes were required in turning the hive 90°, the bees went directly in until the 45° point; from this position until the 135° point was reached the stoppage of the bees increased more and more until no bees went in at the latter position.

Reducing the rate of rotation to 90° in forty-five minutes did not produce any different results from the last experiment. As the hive would approach the 180° point, the path on which the bees arrived would swing back to its old position, thus bringing the bees to the back of the hive.

If the hive was drawn back 50 centimeters from its usual position, the bees returned to the place where the entrance was, and, circling about, some would find the entrance. If drawn back 2 meters no bees found the hive, but circled about its old position in hundreds, going into a box if placed there with a hole where the hive entrance had been.

A chemical "nest material" aids somewhat in entering the hive, but does not play the chief rôle in guiding flying bees. Whatever it is seems to guide them not to the hive but to a point in space where it was when left by the bees.

To ascertain if memory pictures have any part in this, a hive was masked so that even a man would not have recognized either it or its surroundings, but so long as neither red nor white was used, no effect was noticed on the bees. These two colors, however, always seemed to disquiet them, causing a collecting, probably through their dazzling effect. This shows that no memory picture of the hive is retained, and to ascertain whether they fly through memory pictures of the region about the hive, the following experiments were made, in which the city near the Institute, in which few flowers bloom and in which a bee is seldom seen, is assumed to be an unknown region, while the meadows around the Institute are assumed to be known to the bees. In each instance eight marked bees were taken 350 meters

from the hive on quiet sunny days and allowed to fly, the hive entrance being watched 12 minutes, with the following results:

Bees from Meadow.		Bees from City.	
1.)	Used 2⅔ minutes in returning.	1.)	Used 1½ minutes in returning.
2.)	" 4½ " " "	2–4.)	" 2¼ " " "
	No more returned during 12 minutes.	5.)	" 2¾ " " "
		6.)	" 3½ " " "
			Two did not return in 10 minutes.

Greater distances were employed in two other experiments, as follows:

Eight bees carried 400 m. Entrance observed 10 minutes.

Bees from Meadow.		Bees from City.	
1.)	Used 4½ minutes in returning.	1.)	Used 5 minutes in returning.
2, 3.)	" 5 " " "	2.)	" 7 " " "
4, 5.)	" 6 " " "	3, 4.)	" 10 " " "
6–8.)	" ? " " "	5–8.)	" ? " " "

Ten bees carried 650 m. Entrance observed 12 minutes.

Bees from Meadow.		Bees from City.	
1.)	Used 5 minutes in returning.	1.)	Used 4¾ minutes in returning.
2.)	" 5½ " " "	2, 3.)	" 5¼ " " "
3.)	" 7 " " "	4.)	" 7½ " " "
4.)	" 9½ " " "	5.)	" 9 " " "
5.)	" 11 " " "	6, 7.)	" 10½ " " "
6–9.)	" ? " " "	8.)	" ? " " "
10.)	Did not fly from box.	9, 10.)	Did not fly from box.

The bees did not see the Institute, but in nearly every case started in the right direction before flying up over the tops of the houses which were between them and the hive. Memory pictures do not seem to aid them on their homeward journey, but some unknown force, which from the following experiments seems to guide them not to the hive but to a point in space which may or may not be the one in which the hive stands or stood.

Of a number of bees carried in a box a long distance from the hive and liberated, not all returned to the hive, but some, after circling in the air for some seconds, returned to the box, which had been set on a rock before being opened.

These bees were thrown into the air again, and the box removed. This time the bees came to the spot where the box had been.

The bees were again liberated while holding the box in the hand above the ground, then stepping back some distance the bees were observed to come to the spot where the box had been and to circle about it some time.

This unknown force does not operate an infinite distance, but is limited to an area the radius of which is about three miles.

In conclusion, then, the author finds nothing in the phenomena exhibited by bees or ants to prove the existence of any psychical quality. They learn nothing, but act mechanically in whatever they do, their complicated reflexes being set off by simple physiological stimuli.

CASWELL GRAVE.

Studies on Hair. — In the last number of the *Jenaische Zeitschrift* (vol. xxxi, p. 605) Dr. Fritz Römer continues his studies on the integument of mammals in an article dealing with the arrangement of the hair on the African rodent *Thryonomys swinderianus.* In an embryo of this species, about sixteen centimeters long, the head, trunk, extremities, and base of the tail seemed covered with rows of small scales. On closer inspection this appearance was found to be due not to scales, but to the arrangement of the hair. The hairs were placed in short, slightly curved rows, each row containing three, five, eight or twelve hairs. While in any row the middle hairs were longer than the lateral ones, no single, large, central hair could be distinguished, as de Meijere has found in the hair groups of so many mammals. Römer explains the rows of hairs in Thryonomys by assuming that they were originally developed on an ancestral form covered with scales, the rows of hairs alternating with the scales, and the scales afterwards disappearing. Since the publication of de Meijere's paper on the hairs of mammals this theory has been gaining ground. Beside these regularly arranged hairs the embryo examined by Römer showed many small, irregularly scattered hair germs which, upon further examination, were shown to give rise to the fine hairs of the thick winter fur, the summer fur consisting almost entirely of the regularly arranged hairs. The summer fur, then, presumably represents a hair arrangement phylogenetically older than the winter fur.

G. H. P.

The Eyes of Amphioxus. — The organs of vision in Amphioxus have been made the subject of careful study by Dr. R. Hesse.[1] They consist of very simple direction eyes, lying close to the central canal of the spinal cord. They occur from the third muscle segment very nearly to the tail. The eyes are not uniformly distributed along the cord, but are arranged in segmental groups, the groups corresponding to the muscle segments and, consequently, alternating on the two

[1] *Tübinger Zoologische Arbeiten*, Bd. ii, No. 9, 1898.

sides of the cord. While a group near the middle of the animal may contain as many as twenty-five eyes, near the anterior or posterior ends a group may be represented by a single eye only. Each eye is composed of a sensory cell, so surrounded by a pigment cell that the former is accessible to light only from one direction. In general, the eyes ventral to the central canal face ventrally, as do those in the right half of the cord, while those in the left half face dorsally. Notwithstanding these anatomical differences, the living animal shows no special response to light coming in a particular direction.

G. H. P.

Note on the Mydaidæ of New Mexico. — Prof. S. W. Williston has recently published (*Tr. Kansas Acad. Sci.*, vol. xv) some interesting notes on these curious flies. He remarks: "Collections of Diptera, even large ones, rarely include many specimens or species of Mydaidæ." They are, in general, of southern distribution, though one species (*Mydas clavatus*) occurs rarely in Massachusetts. The first species observed in our region were those taken by Captain Pope on the Pecos River, somewhere about the Texas and New Mexico boundary. No less than four species from Pope's collection were described by Loew, as *Leptomydas venosus*, *Mydas luteipennis*, *M. simplex*, and *M. xanthopterus*. Dr. Williston, in his paper cited, adds a new species, *Ectyphus townsendi*, collected by Townsend at Las Cruces, N. M.; and also records *Mydas decar* O. S., and *M. basalis* Westw., as taken in New Mexico by F. H. Snow, but unfortunately omits to say just where.

On June 27, 1897, the writer was collecting grasshoppers with Mr. A. P. Morse, of Wellesley College, in the mesquite zone back of the Agricultural College, in the Mesilla Valley. Nearly at the same time, I took an example of *Mydas carbonifer* O. S., and Mr. Morse took one of *M. luteipennis* Loew, these being the first Mydaidæ I had come across in several years' collecting. They were determined for me by Mr. Coquillett, of the Department of Agriculture. *M. carbonifer* is a black fly, well deserving its name, which seems to have a remarkable range. Osten Sacken's type was taken by Professor Comstock at Norton's Landing, Cayuga Lake, N. Y., and not only does it range south to New Mexico, but Williston (*loc. cit.*) refers provisionally to this species an example from Chapada, Brazil, doubtless collected by H. H. Smith, though it is not so stated.

M. luteipennis, which was also taken by Pope, is a large blue-black fly with red wings, so closely resembling *Pepsis rubra*, a formidable

Pompilid wasp common in the same locality, that we may regard it as a true mimic. Dr. Williston, describing another Mydaid (*Ceriomydas fraudulentus*) from Chapada, Brazil, remarks that it shows a remarkable mimicry of certain species of *Conops*, occurring in the same region. Is it not, perhaps, likely that both the *Ceriomydas* and the *Conops* mimic some Hymenopteron?

T. D. A. Cockerell.

Zoölogical Notes. — Mr. A. E. Shipley, of Cambridge, England, has a valuable paper on the species of the peculiar group of parasites, the Linguatulidæ, in the first number of Blanchard's *Archives de Parasitologie.*

In the first number of the thirty-second volume of the *Jenaische Zeitschrift* are three papers dealing with the anatomy of the whales. Dr. Friedrich Jungklaus describes the stomach in the young and in some cases of the adult of six species of Cetacea. Among his conclusions he finds a striking difference between the stomachs of the toothed and the whalebone whales, that of the toothed whales differing far more from the normal mammalian whales than does that of the mystacocœtes. On the other hand, the resemblances between the two types are regarded as the result of convergence. Otto Müller discusses the alterations which the respiratory organs have undergone in the adaptation of these animals for an aquatic life, some other aquatic mammals being introduced for comparison. Wilhelm Dandt discusses the urogenital apparatus of the Cetacea. He concludes that the great development of the kidneys is due to the watery nature of the food, since in the absence of sweat glands all water must be eliminated by the lungs and kidneys. The strongly marked lobulation of the kidneys is secondary, not primitive. In the fœtus the penis is external, but it becomes internal during embryonic life. The accounts in these three papers go far towards supporting the thesis that the Cetacea is a group of polyphyletic origin, and their resemblances those of convergence.

Proceedings of the Biological Society of Washington, vol. xii, pp. 85–114, April 30, 1898, contains Bailey, V.: Descriptions of Eleven New Species and Subspecies of Voles. Bangs, O.: A New Raccoon from Nassau Island, Bahamas; Description of a New Fox from Santa Marta, Columbia; A New Marine Opossum from Margarita Island. Merriam, C. H.: The Earliest Generic Name for the North American Deer, with Descriptions of Five New Species and Subspecies; Descriptions of Two New Subgenera, and Three New Species of Microtus from Mexico and Guatemala; Descriptions of Twenty New

Species, and a New Subgenus of Peromyscus from Mexico and Guatemala; A New Genus (Neotomodon), and Three New Species of Marine Rodents from the Mountains of Southern Mexico. Miller, J. S., Jr.: A New Rabbit from Margarita Island, Venezuela. Palmer, T. S.: Notes on the Nomenclature of the Cheiroptera.

BOTANY.

Pfeffer's Physiology of Plants.[1] — Only the first of the two volumes of Pfeffer's *Pflanzenphysiologie* has yet appeared, the second being still in preparation. So thoroughly is this book being rewritten that it is very likely that the translations of the first volume — the French translation to be issued by a Paris publisher unaided by any subvention, I believe, and the English one to be issued by the Clarendon Press of Oxford — will be out before the second volume of the German edition is ready.

The plan of the work is the same as that of the first edition, the author confining himself to pure physiology, instead of enlarging the scope of the book to include that branch of physiology, œcology, or making more than passing allusions to the applications in agriculture, brewing, medicine, and surgery, of facts discovered and elucidated by plant physiologists. The book is a handbook, not a textbook; a critical review of the contributions to plant physiology, and a statement of the facts as they appear in the light of past discoveries and present hypotheses. It is by no means a compilation, for in almost every part of the field Pfeffer has worked, or led his students to work, fruitfully. This fact lends additional value to the critical discussions of the work of other and sometimes disagreeing investigators, and to the appreciation of the difficulties in the way of making experiments, and of drawing conclusions therefrom, — an appreciation which gives deeper insight into a problem as well and lends patience to its discussion.

In estimating the value of the book, for the facts, new and old, brought together for the first time in it, account must be made in equal amount of the skill and clearness with which defects in argument, faults in conclusion, and overzeal in theorizing are pointed out.

[1] *Pflanzenphysiologie.* Ein Handbuch der Lehre vom Stoffwechsel und Kraftwechsel in der Pflanze. Von Dr. W. Pfeffer. Zweite völlig umgearbeitete Auflage. Bd. I, Stoffwechsel. Leipzig, 1897, Wilhelm Engelmann.

Whatever may be thought of the generally involved style of Pfeffer's exposition — and this has been complained of for years by his own countrymen quite as much as it has been deplored by others — nothing could be clearer and crisper than some of his critical remarks. He goes directly to the point, and states it clearly. Regarding the exposition, I believe that it, too, is clearer and simpler than in the first edition and than in many of Pfeffer's papers; but it can never be "easy reading" for any foreigner because of the detail of fact and theory into which Pfeffer goes in his treatment of every topic.

What DeBary's *Comparative Anatomy of the Vegetative Organs of the Phanerogams and Ferns* was intended to be and what it has been for plant anatomy, Pfeffer's *Handbuch* was in the first edition, and cannot fail to continue to be in the second, for plant physiology. In the survey of what has been discovered are pointed out many of the problems which remain to be solved. Thus knowledge is broadened and zeal for research is kindled and directed.

The first volume is devoted to the consideration of the subject announced by the title, namely, "Stoffwechsel," or metabolism in the broad sense. Before treating of this, however, the author presents three chapters covering nearly seventy-five pages. The first is an introductory one broadly stating the object of physiology, — "to study the manifestations of life as such, to trace these back to their nearer and further causes, and to become acquainted with these in their significance for the organism"; the second is devoted to a discussion of the cell from the morphological-physiological standpoint; the third deals with the phenomena of swelling as indicating molecular structure. The remaining five hundred and fifty pages in this volume are occupied with the subject of nutrition, — respiration (and the fermentations dependent upon the respiration of certain organisms) being considered as a part of the destruction processes concerned in the nutrition of the organism.

Within the limits of a review, any adequate treatment in detail of the contents of this volume is impossible. The student of physiology, whether he use animals or plants as the subjects of his observation, will find the book rich in facts, broadening in its masterly treatment of the conceptions to be built upon these facts, and inspiring in the high, enthusiastic, yet controlled devotion of the author to the subject to which he has so fruitfully devoted his life, and in which, as teacher and writer, he has led so many others.

George J. Peirce.

Living Plants and their Properties.[1] — These essays were read, on various occasions within the last few years, to audiences as diverse as the Linnean Society of London and "The Parlor Club, an organization devoted to literary and scientific culture, Lafayette, Indiana," or else were published in magazines, bulletins of agricultural experiment stations, etc.

The preface expresses the hope that this volume will arouse a more general interest in the phases of botany treated. The reviewer fears that the general reader will be discouraged by two qualities common to the majority of the essays. First, the number of undefined technical terms, familiar enough to botanists, but rather appalling to others, and of Latin generic names, unaccompanied by any suggestion as to the family of the plants spoken of, is unfortunately large. Second, the absence of definite conclusions concisely summed up at the end of discussions.

If so much adverse criticism may be brought against the book, much may, on the other hand, be said in its favor. The authors are professional botanists, know what they are talking about, and have the faculty of saying things attractively. More than this, in treating physiological subjects and problems, they consistently indicate the fundamental identity of the functions of animals and plants, and show that this is due to their having the same living substance as the physical basis of their existence. The elucidation and the understanding of any function of a plant is greatly facilitated by a comparison with the much more familiar expression of the same function in man or in some other animal; but it does not necessarily follow, as is well stated in the essay on the special senses of plants, that all the advantage is on one side. When animal and plant physiologists realize that they have common problems which they can best work out together, they will be as helpful to each other as the animal and plant cytologists have been and still are; and together they will be more effective in advancing knowledge than when the one cleaves only to muscles and the other to roots.

George J. Peirce.

A New Botanical Journal. — The following preliminary announcement of a new periodical has just been received:

The New England Botanical Club is considering the publication of a monthly journal, to begin January 1, 1899. It is to be an octavo of about

[1] *Living Plants and their Properties.* A collection of essays by Joseph Charles Arthur, Sc.D., and Daniel Trembly MacDougal, Ph.D. New York, Baker and Taylor, 8vo, 242 pp., 30 pls., and figures.

sixteen pages each issue, and illustrated by full-page plates. It will deal primarily with the flora of New England, especial attention being given to rare plants, extended ranges of distribution, and newly introduced, as well as newly described, species. Articles have been already promised by many of the foremost New England botanists, both professional and amateur, and while a high standard will be maintained in the matter of scientific accuracy, needless technicality of style will be carefully avoided, so that any person who can use *Gray's Manual* will be able to read the proposed journal with pleasure and interest. Not only the flowering plants and ferns, but fleshy fungi and other cryptogams will receive attention. The price of the journal has been fixed at one dollar per annum.

While more than two hundred subscriptions have already been promised in advance, the Club does not feel warranted in proceeding with its plan of publication unless assured of much further support. All persons interested in botany and in the maintenance of such a journal in New England are earnestly solicited to send at once subscriptions for at least one year (which, however, need not be paid before January 15, 1899) to

EDWARD L. RAND,
Corresponding Secretary N. E. Botanical Club,
740 Exchange Building, Boston, Mass.

It may seem remarkable that with the many existing botanical periodicals it should be thought necessary to establish new ones, but it is clear that the journal here contemplated will be devoted to a field not at present cultivated by any existing periodical, namely, the local flora of New England. The journal will, doubtless, be largely systematic, and will attempt to do for New England what such periodicals as the *Deutsche Botanische Monatschrift*, *Œsterreichische Botanische Zeitschrift*, etc., have long done so admirably for the European regions they cover. In the present enthusiasm for histology, cytology, œcology, and vegetable physiology, it is not uncommon for a botanical student to plunge into structural problems of extreme technicality without adequate systematic training to give him a proper sense of proportion in his work. To know well the different groups of some one local flora is not only in itself a great source of pleasure, but is a most excellent preparation for subsequent histological or physiological study. There is, furthermore, a great deal still to do upon the systematic botany of New England. Some of the most common species of plants are proving themselves to be puzzling aggregates of closely related forms, each of which must be studied separately before its proper status and exact distribution can be learned. The flora is constantly changing, through the extermination

of species in certain localities, and the still more common introduction of plants of the Old World. There are many reasons why these changes should be carefully watched and duly recorded. Papers dealing with these matters, however, are chiefly of local interest, and lose much of their instructive power and significance if published in a journal remote from the field they cover. It is, doubtless, with a clear perception of these conditions that the New England Botanical Club proposes to issue a small but convenient medium for such communications regarding the flora of New England. The Club was founded in December, 1895, and now contains thirty-five resident members (those living within twenty-five miles of Boston), and as many non-resident members. Its annually elected presidents have been Prof. W. G. Farlow, Mr. N. T. Kidder, and Prof. G. L. Goodale. The herbarium of the Club is situated in the Botanical Museum at Cambridge, Mass. It has been of rapid growth, and is likely to become the most complete local collection of New England plants. The earnest and scholarly *personnel* of the New England Botanical Club is the best guarantee for the success of the proposed journal.

B. L. R.

Garden-Making.[1] — While horticulture is an art rather than a science, its methods and results have such a manifold bearing upon plant life that a good work on gardening must always have a great interest for botanists. The 400-page octavo now at hand is neat, carefully planned, and copiously illustrated. It is true, in this age of handy manuals, these may not seem very exceptional qualities, but Professor Bailey's book has still more to recommend it. It comprises the result of much experience, is simple and practical in its suggestions, and, above all, is written in a style which is animated and really entertaining. Suggestive works on horticulture are not rare; that is, books which are either repositories of carefully stated facts or books which with less critical presentation of facts have a pleasing style, but a book which combines a wealth of accurate and practical information with a clear, vivacious, and at times even humorous style is truly exceptional.

To many people a garden is a source of more discouragement and vexation than of pleasure. To such persons Professor Bailey's charmingly facetious introduction must come as a cheering philosophy, renewing interest and inspiring courage. It runs: "Every family can

[1] By L. H. Bailey, aided by L. R. Taft, F. A. Waugh, and E. Walker. Published by the Macmillan Co., New York, 1898. $1.00.

have a garden. If there is not a foot of land, there are porches or windows. Wherever there is sunlight, plants may be made to grow; and one plant in a tin can may be a more helpful and inspiring garden to some mind than a whole acre of lawn and flowers may be to another. The satisfaction of a garden does not depend upon the area, nor, happily, upon the cost or rarity of the plants. It depends upon the temper of the person. One must first seek to love plants and nature, and then to cultivate that happy peace of mind which is satisfied with little. He will be happier if he has no rigid and arbitrary ideals, for gardens are coquettish, particularly with a novice. If plants grow and thrive, he should be happy; and if the plants which thrive chance not to be the ones which he planted, they are plants, nevertheless, and nature is satisfied with them. We are apt to covet the things which we cannot have; but we are happier when we love the things which grow because they must. A patch of lusty pigweeds, growing and crowding in luxuriant *abandon*, may be a better and more worthy object of affection than a bed of coleuses in which every spark of life and spirit and individuality has been sheared out and suppressed. The man who worries morning and night about the dandelions in the lawn will find great relief in loving the dandelions. . . . If I were to write a motto over the gate of a garden, I should choose the remark which Socrates made as he saw the luxuries in the market: 'How much there is in the world that I do not want!' . . . I expect, then, that every person who reads this book will make a garden, or will try to make one; but if only tares grow where roses are desired, I must remind the reader that at the outset I advised pigweeds. The book, therefore, will suit everybody, — the experienced gardener, because it will echo of what he already knows; and the novice, because it will apply as well to a garden of burdocks as of onions."

After this cheery introduction follows a host of practical suggestions regarding the preparation of soil, selection and use of implements, choice of sites, arrangement of borders, shrubbery, and paths, times of planting, qualities and relative desirability of different species of plants, protection of plants from insects and parasites, desirable forms of hothouses, etc. Especially noteworthy among the many sketchy but very telling illustrations are the "informal flower border" (drawn by Mr. F. Schuyler Mathews) and the contrasting pictures of "a house" and "a home." The whole work is a most forcible argument for informality in horticulture.

In connection with *Garden-Making* may be mentioned another

similar and still more recent manual by the same author, and called the *Pruning Book*. It is also one of Professor Bailey's "Garden-craft series," and, like its companion volumes, is full of well-told and practical information upon its subject, which, of course, primarily interests those engaged in the care of ornamental trees, shrubbery, orchards, or vineyards.

B. L. R.

Sulphur Bacteria. — Prof. Manabu Miyoshi gives an interesting preliminary account[1] of some of the organisms found in the hot sulphur springs of Japan. The first part of the paper consists mostly of field observations on a long scythe-shaped, peritrichiate, colorless, gelatinous bacterium which grows in masses in the hot springs of Yumoto and is covered with sulphur. The second part consists of an account of species of cophromatium and various other one-flagellate purple or rose-colored water organisms which frequently occur in patches in pools and swamps in the vicinity of the sulphur springs.

The scythe-shaped peritrichiate form is mostly $20 \times 1.4\ \mu$ in size, but other much smaller curved rods occur. In places, also, species of Beggiatoa and Thiothrix may be found. The gelatinous masses grow only near the surface of the water in rapid-flowing hot streams charged with sulphide of hydrogen. They do not occur in quiet water, or in the depths, or in water cooler than 51° C. They are able to grow in very hot water, having been found in rapid streams, the temperature of which was 68° to 69.8° C. (154.4° to 157.6° F.). They have only been found in water containing sulphide of hydrogen, and this gas is believed to be necessary to their growth. Free access of oxygen is necessary to bring about the deposit of the sulphur crystals. The organisms will grow in closed conduits, but no macroscopically visible sulphur is deposited on them. When such masses were removed and put into open running water there was an immediate deposit of sulphur, and in an hour they became indistinguishable from the surrounding flocks. The sulphur deposit, which is very copious, and always, or at least usually, on the outside of the rods, covers even the thinnest threads, and appears to be in some way connected with specific properties of the gelatinous covering of the organisms. No deposits of sulphur at all comparable could be obtained by putting into the water fine linen threads covered with starch jelly, half coagulated albumen, concentrated gela-

[1] M. Miyoshi, Studien über Schwefelrasenbildung und die Schwefelbacterien der Thermen von Yumoto bei Nikko, *Journ. College Sci.*, Imp. Univ., Tōkyō, vol. x, Pt. ii, pp. 143–173, 1897.

tin or thick glue. Under favorable conditions this growth is extremely abundant and very conspicuous, filling the streams and pools with white or yellowish-white, thready, flocculent, firmly anchored, streaming masses, which are usually 3 to 5 cm. long, but which in small rapid brooks sometimes reach a length of 20 cm. The water of Yumoto is only very feebly acid, but contains a large amount of sulphide of hydrogen (about 0.04 grams per liter), and also considerable calcium bicarbonate (0.0624 grams per liter). Professor Miyoshi suggests that these organisms, the protoplasm of which must be endowed with great energy owing to the temperature at which it grows, oxidize the H_2S *directly* to H_2SO_4, which acid does not interfere with the life of the bacteria because it is quickly neutralized by the alkaline bicarbonate of the running water. A discussion of the morphology and physiology of these organisms is reserved for a subsequent paper, no opinion being ventured as to whether the gelatinous masses consist of one or of several species.

In the second part, the chemotropism of *Chromatium weissii* is discussed, and some new genera and species of the red sulphur bacteria are established. The three new genera are Thioderma, Thiosphærion, and Thiosphæra. Using Pfeffer's capillary method he obtained among others the following results with *Chromatium weissii.* It was powerfully attracted by the following substances: water containing various quantities of sulphide of hydrogen, 0.3% potassium nitrate, 0.3% ammonium nitrate, 0.3% ammonium phosphate, 0.5% ammonium tartrate, 0.3% potassium sodium tartrate, 0.3% monopotassium phosphate (neutralized by sodium carbonate). It was feebly attracted by 0.5% cane sugar, 0.5% grape sugar, 0.5% milk sugar, 0.5% asparagin. It was nearly indifferent to 0.5% glycerine, 0.3% magnesium sulphate, 0.3% ammonium chloride. It was strongly repelled by 0.5% malic acid. The organism also reacts to contact irritation. The temperature of the water in which these red bacteria grew was 23° to 35° C. An attractive lithographic plate accompanies the paper.

ERWIN F. SMITH.

Ripening of Cheese. — Persons who are fond of Roquefort, Camembert, and other piquant cheeses will be surprised to learn that fully one-half of the bulk of such cheeses, and often much more, consists of the mycelium and spores of fungi. These are not accidental impurities but necessary constituents, by means of which the various cheeses are ripened, and to which they owe their peculiar flavors. In reality, those who eat these appetizing cheeses consume

more fungus than cheese. The author of these statements is Dr. Olav Johan-Olsen,[1] the well-known mycologist, who will be remembered as joint author with Drs. Brefeld and Istvánffy of two large volumes on basidiomycetous fungi (Hefte vii and viii of Brefeld's *Untersuchungen*). For some years Dr. Johan-Olsen has been in charge of a royal Norwegian laboratory for the study of fermentations, and has had unlimited facilities for experimental cheese-making, and also good opportunities for studying the cheese industry in France and other parts of Europe. He has spent ten years in his efforts to discover exactly how to make cheeses of special brands, has used up more than 110,000 liters of milk, and has made thousands of microscopic examinations and special cultures, more than 500 different organisms having been isolated from a single variety of cheese. He now declares that his work has passed out of the experimental stage, and that he has discovered exactly how to make (by adding pure cultures of specified organisms to sterile or nearly sterile milk) well-known cheeses on a commercial scale. For example, one of the finest Norwegian cheeses is known as Gammelost. This cheese has a peculiar flavor, suggestive of apples, citron, and Camembert cheese, and always brings a good price. It is made by peasants in huts in the mountains, and there are so many uncertainties connected with its rule-of-thumb manufacture that only 10% of the product is first-class. By means of his pure-culture inoculations Dr. Johan-Olsen is now able to make this cheese on a large scale with a high degree of certainty, 90% of the product being first-class, without bad odor, with very fine flavor, and with better appearance and better keeping qualities than the same cheese as ordinarily made. No less than 15,000 kilos of this scientifically ripened cheese was produced last year. For a long time Dr. Johan-Olsen's experiments were barren of practical results, owing to his belief that the ripening of the cheese was due to bacteria. The abandonment of this hypothesis was followed by the discovery that the ripening and peculiar flavor of the most celebrated cheeses are due to the presence of fungi, and, what is still more interesting, to the joint action of several different sorts, one alone not being able to bring about the desired result. Until this symbiotic relationship was discovered he declares that hundreds and thousands of his cheese experiments miscarried, so that many of the cheeses had to be thrown away. In

[1] O. Johan-Olsen, Die bei der Käsereifung wirksamen Pilze, *Centralb. f. Bakt., Parasitenkunde, u. Infektionskr.*, Abt. ii, Bd. iv, No. 5, March 5, 1898, pp. 161–169.

case of the Gammelost the ripening and flavoring are accomplished by adding to the sour, coagulated skimmed milk two fungi, *viz.*, a Penicillium and a Mucor. The blue mold used is not *P. glaucum*, which always spoils the cheese when it gets into it, but a hitherto unrecognized species, *P. aromaticum.* In the green cheese, which is said to taste like sour horn, dead yeast and lactic acid organisms prevail; in the ripe cheese, which has an entirely different structure and appearance, Mucor and Penicillium are very abundant, Mucor being most abundant and exerting the predominant influence if the cheeses are ripened at high temperatures, and Penicillium if they are ripened at moderate temperatures.

We are not told what fungi should be used to ripen and flavor Gorgonzola, Roquefort, Camembert, and Norwegian cheese (goat cheese), but are given to understand that these problems have been solved, and also that he will soon be in condition to give exact directions for making Stilton, Gouda, Eidam, Cheddar, Emmetthaler, and other cheeses. The paper from which these statements have been taken is illustrated by six lithographic plates showing Gammelost and the fungi required to ripen and flavor it. ERWIN F. SMITH.

A New Check-List of North American Plants.[1] — At the Buffalo meeting of the American Association the botanists interested in the Rochester nomenclature decided to prepare a reform check-list of the higher plants of North America. This list, except in its greater territorial scope, was to be much like the one already issued for northeastern North America. The work, we believe, was to be assigned so far as possible to specialists, each of whom should treat only such groups as were most familiar to him. It is needless to say that many botanists have grave doubts as to the value of such a list. They see clearly that the Rochester nomenclature, instead of being an ideal system, has serious defects which will, as they believe, preclude its ultimate success. However, if such a list was to be prepared at all, there is reason to commend the coöperative plan adopted. The consistent application of any new principle of nomenclature to the flora of such a vast area is a matter of great and obvious difficulty, and it was the hope of the conservatives as well as the reformers that the work, if undertaken, might be carried out with caution and scholarly methods. For these reasons it is a matter for general regret that the proposed critical list has been anticipated

[1] Heller, A. A. *Catalogue of North American Plants North of Mexico, Exclusive of the Lower Cryptogams.* Minneapolis, March 10, 1898.

by a crude and hasty compilation. Mr. Heller has undoubtedly prepared and issued his list with sincere conviction that he was thereby advancing the cause of the Rochester nomenclature and meeting a need of American botanists. But in these days of critical work and high bibliographical ideals, when references are carefully verified and proofs repeatedly read, the appearance of a work containing so many glaring errors can scarcely commend any system.

A slight examination of the list shows such "first correct combinations" as *Silene cucubalus*, *Arenaria sajanensis*, and *Anoda lavateroides* on equal footing with Rochester names, some of which are their exact synonyms. Names indorsed by the *Illustrated Flora* appear on the same pages with others, such as Cheiranthus (for Erysimum), which are quite opposed to the usage of Messrs. Britton and Brown. All the Cerastiums are appended to Arenaria. Misprints abound. Some good species are omitted. Genera are subjected to extreme subdivision and many obvious varieties are ranked as species. In some cases the same species, such as *Montia sarmentosa* and *M. saxosa*, appear coördinately under different genera. *Trifolium gracilentum* and its variety are repeated under different numbers. No care has been taken to give consistent and uniform abbreviations of authorities. Thus on a single page of the Cactaceæ the eye meets "Engelm. & Bigel.," "E. & B." "Engel. & Bigel.," "Eng. & Big.," "Engelm. & Big.," and "Englm." Finally, a considerable number of pure synonyms are rehabilitated.

After wandering about in this nomenclatorial maze, the bewildered reader, in hope of finding some key to it, turns to Mr. Heller's preface, there to learn that during the last few years "a more stable system of nomenclature has been introduced." Is this irony? Surely, if the author knew of such a system, he might have divulged it for the good of his fellow-botanists, and not have jumbled up "Kew rule" names, on the one hand, with Brittonian and Greenean names, on the other, to say nothing of a liberal admixture of the merest synonyms.

No genus has been more discussed by the reformers than the one which they call Tissa. The group has been revised by one of their number and largely augmented by another. The generic name Tissa, which meets with little favor by the rest of the world, has in a way become the shibboleth of the Rochester reformers. Let us see how Mr. Heller treats this much-emphasized genus. He recognizes sixteen species and varieties. Of these *T. clevelandi* and *T. leucantha* have incorrect parenthetical authorities; *T. clevelandi*

Greene and *T. villosa* Britton are exact synonyms, founded upon the same plants of the Pacific slope; *T. macrotheca*, var. *scariosa*, and *T. pallida* are also perfect and confessed synonyms; the recent *T. gracilis* is identical with the much older *Spergularia plattensis* of South America; *T. salsuginea* Bunge is an impossible combination as the last of Bunge's many papers was published before the resurrection of Tissa, while *Spergularia salsuginea* (Bunge) Fenzl in its American use is an exact synonym of *T. diandra*. Thus, of Mr. Heller's sixteen species and varieties about half are either repeated under some obvious synonym or are adorned with incorrect authorities. These are not differences due to divergent botanical opinion. They are clearly errors of careless compilation, all of which could have been easily avoided by slight study of the recent monographs. Surely, this is not the best that our reformers can do with their pet genus after more than five years of unprecedented activity.

B. L. R.

A Review of Canadian Botany.[1] — The second portion of Professor Penhallow's admirable historical sketch, now before us, traces botanical activity in Canada from 1800 to 1895. The first few pages describe the Canadian work of the younger Michaux, Pursh, F. A. Holmes, Titus Smith, Goldie, the Hookers, La Pylaie, Brunet, Provancier, the late George Lawson, Sir William Dawson, and some others. Attention is then directed to the botanical gardens, societies, and collections of Canada, to the results of the Natural History Survey under Professor Macoun, and to the facilities for botanical work in the leading educational institutions of the country. The larger and by far the most valuable part of the paper, however, is an excellent bibliography of Canadian botany during the period covered. This list contains nearly five hundred titles and shows exceptional care and attention to detail.

B. L. R.

Coastal and Plain Flora of Yucatan.[2] — Dr. Millspaugh's third important paper upon the flora of Yucatan is an annotated list of plants collected by Dr. Arthur Schott in 1864–66, by Mr. Whitmer Stone in 1890, and by Dr. George F. Gaumer in 1895–96, together with some notes and new species by Professor Radlkofer and Dr. Loesener. This catalogue enumerates more than three hundred species and varieties not hitherto recorded in the flora of this poorly known territory. No one who has not had some experience in

[1] Penhallow, D. P. *Trans. Roy. Soc. Canad.*, ser. ii, vol. iii, sec. 4, pp. 3–56.

[2] Millspaugh, C. F. *Publ. Field. Columb. Mus.*, No. 25, issued January, 1898.

the scattered literature of Mexican botany and the great difficulty of identifying tropical plants is likely to appreciate the patience and perseverance required to prepare a list of this kind. Until Dr. Millspaugh turned his attention to Yucatan, it was botanically one of the least-known parts of our continent. Both from the character of its inhabitants and the perilous nature of its climate the region has always been especially difficult to explore. The exceptional energy with which Dr. Millspaugh has overcome these difficulties and collated in such a convenient form the results of his personal observations and those of others merits much praise.

B. L. R.

Oudemans's Fungi of the Netherlands.[1] — In this large work, the second volume of which appeared last year, we have one of the most interesting and carefully elaborated fungus floras which has yet appeared. It represents the ripe life work of the well-known mycologist Dr. Oudemans, and both in its preparation and publication great pains has been taken to make an attractive and useful book. Were it simply a local flora, there would be no need of mentioning it here. It is much more than this for several reasons: (1) many of the species described in it are of wide distribution; (2) the generic and specific characters have been worked over independently, apparently with great care, and therefore are very useful for comparison with those of Saccardo, Winter, Schroeter, and other authors; (3) considerable attention has also been given to bibliography and synonomy. These two volumes deserve a place in the library of every critical student of the fungi, and it is to be hoped that the life and strength of the author may be spared to complete the work by the addition of a third volume on the *fungi imperfecti*. The volumes are printed in clear type on good paper and wholly in French. Each volume is indexed. Volume ii also contains a host index and fourteen plates of figures illustrating the genera of the Pyrenomycetes. The latter are a second edition of Saccardo's "Genera Pyrenomycetum schematice delineata" with the figures redrawn and corrected where necessary.

ERWIN F. SMITH.

[1] Oudemans, C. A. J. A. *Révision des Champignons des Pays-Bas*. Amsterdam, Johannes Müller. Tome i, Hyménomycètes, Gastéromycètes, et Hypodermées. 8vo, 638 pp. 1892. Tome ii, Phycomycètes, Pyrénomycètes. 8vo, xvi + 518 pp., tab. xiv. 1897.

PALEONTOLOGY.

Spencerites.[1] — This genus is founded upon the *Lepidostrobus insignis* and *Lepidodendron spenceri* of Williamson, whose material consisted of cones with their detached peduncles, but no vegetative parts. The specimens were derived from the coal measures of Lancashire and Yorkshire, and were first described by Williamson in 1878.

A review of this material in conjunction with additional specimens from different sources, convinces Dr. Scott that the characters presented by the cones are such as to demand the institution of a new genus under the name of Spencerites. To this are assigned Williamson's *Lepidodendron spenceri*, from which the generic name is taken, and *Lepidostrobus insignis*, under the name of *S. insignis*. The essential features of this species are found in the course of the leaf trace bundles; in the peltate form of the sporophylls which consist of a short, cylindrical pedicel expanding into a relatively large lamina; the approximately spherical sporangia which are quite free from the pedicel, but attached by a narrow base to the upper surface of the lamina where it begins to expand, and in the characteristics of the spores which are intermediate between the microspores and macrospores of Lepidostrobus and are provided with a hollow wing formed from the dilated cuticle about the equator.

Spencerites majusculus, a new species, is a large plant with larger cones; the sporophylls are more numerous, but the spores are much smaller, form quadrants of a sphere, and have narrow wings along their three angles.

The genus differs from Lepidostrobus chiefly on account of the different mode of insertion of the sporangia, the structure of the sporangial wall and of the spaces, and also the whole habit of the cone.

Cheirostrobus.[2] — From the well-known Calciferous Sandstone Series at Pettycur, on the Firth of Forth, there has been obtained an entirely new type of cone which Dr. Scott describes under the name of *Cheirostrobus pettycurensis*, thus adding to the eight distinct types

[1] Scott, D. H. On the Structure and Affinities of Fossil Plants from the Palæozoic Rocks, *Phil. Trans. R. Soc.*, Ser. B, 189 (1897), 83–106.

[2] Scott, D. H. On Cheirostrobus, a New Type of Fossil Cone from the Lower Carboniferous Strata (Calciferous Sandstone Series), *Phil. Trans. R. Soc.*, Ser. B, 189 (1897), 1–34.

of cones already known as occurring in the Palæozoic rocks. As found in a calcified form, the cone, somewhat flattened, measures about 5 cm. in its greatest, and from 2 to 2.3 cm. in its shortest diameter. It consists of a cylindrical axis bearing numerous compressed sporophylls arranged in crowded, many membered verticils. Each sporophyll is divided nearly to its base into an inferior and a superior lobe; the lobes are palmately divided into segments, of which half are fertile and half are sterile, each segment consisting of an elongated stalk bearing a terminal lamina. The large sporangia, of which there are usually four on each sporangiophore, are attached by their ends remote from the axis, to the peltate laminæ of the sporangiophores, and contain numerous spores. These latter are about .065 mm. in diameter.

While there are certain features which suggest comparison with certain Gymnosperms, Dr. Scott concludes that in reality it belongs to the Sphenophylleæ, presenting, in certain respects, a remarkable agreement with such forms as *Sphenophyllum dawsoni* and *S. Cuneifolium*. From the additional light which this plant throws upon the allied genus, the Sphenophyllineæ are regarded as representing a generalized type combining many of the features of Equisetineæ and Lycopodineæ, and indicating the common origin of these two series.

Lepidophloios.[1] — Recent studies of material collected during the past fifty years enable the author to separate two species under the names of *Lepidophloios acadianus* and *L. cliftonensis*. The genus is represented by large and dichotomously branching trees bearing very long and linear leaves. The usually stout branches give rise to slender branchlets bearing spirally arranged and stalked cones. The persistent leaf bases give to the stem a rugged and scaly appearance, but as these characters are removed by decay or other causes, there often remains only a smooth surface bearing mere traces of the original leaves, hence much of the material properly belonging to this genus has been described under the name of Halonia and Bothrodendron.

The internal structure conforms to the Sigillarian type. The author shows that the genus is clearly related to Lepidodendron, with which it may readily be confounded, and summarizes his views as to the general relations of this and allied genera in the statement

[1] Dawson, Sir J. W. On the Genus Lepidophloios as Illustrated by Specimens from the Coal Formation of Nova Scotia and New Brunswick, C. M. G., *Trans. R. Soc. Can.*, Second Ser., III (1897), iv, 57.

that the "Sigillariæ are to be regarded as a central generalized group, from which, in regard to structure and affinities, various genera radiate towards Cycads and Conifers on the one hand and Lycopods and Equisetums on the other." D. P. P.

PETROGRAPHY.

The Classification of Igneous Rocks. — Messrs. Iddings[1] and Cross[2] have contributed two interesting articles on that most attractive of all petrographical problems, the classification and naming of igneous rocks. Although attacking the subject from entirely different standpoints, both authors nevertheless reach approximately the same conclusions. Cross declares that "the impossibility of setting up an all-embracing natural classification of igneous rocks is not due to ignorance. It comes from the nature of the rock. The more we know the less shall we be able to include all relations in one classification." Iddings states "that a systematic classification of all kinds of igneous rocks cannot be put on the same basis as a philosophical treatise of the subject-matter of petrology, which takes cognizance not only of the material character of rocks, but also of the laws governing their production, eruption, mode of occurrence, and solidification, as well as their subsequent alteration."

Iddings discusses critically, with the aid of diagrams, the composition of igneous rocks, as indicated by nine hundred and fifty-eight analyses, and shows that no chemical classification will exhibit the true genetic relationships existing between different rock types, and that a mineralogical classification is likewise useless for this purpose. It is, therefore, of no avail to attempt a genetic classification of rocks if it is desired by the classification to group together those rocks that have like characters, in order that they may receive a common name. The present classification, and the nomenclature to which it has given rise, are both unsatisfactory. The need for a new nomenclature is especially pressing, and yet "the condition of our knowledge at present is scarcely such as to warrant the immediate attempt to create a systematic nomenclature."

The point of Cross's paper is to the effect that the present unsatisfactory condition of rock classification is due to the fact that too many

[1] Iddings, J. P. On Rock Classification, *Journ. of Geol.*, vol. vi, p. 91.

[2] Cross, W. The Geological *versus* the Petrographical Classification of Igneous Rocks, *Journ. of Geol.*, vol. vi, p. 79.

relationships are expected to be shown in it. He believes "that no great progress in systematic petrography is possible until a more rational view of the relationship of that science to geology prevails among its devotees." The rock, in petrography, is a unit of material; while in geology it is a unit of form or mass. The geological rock is the subject of study in *petrology*. The classification of rocks in *petrography* should be a classification based on facts and not on theories; it should be based on the properties of the rocks themselves, and upon their relationships to one another and to the earth. No natural classification of rocks is possible, because of the nature of these bodies. "The systematic classification of rocks, according to which their specific names are applied, must be based on their properties as objects, together with only such geological criteria as may be found adaptable, to the end that the system may be uniform, stable, and as natural as possible." The author examines critically the accepted scheme of classification as now used, and shows that it is illogical, being based primarily on geological criteria that are largely theoretical. He objects also to the founding of the classification upon such hypothetical factors as those embraced in the theory of magmatic differentiation. On the other hand, "the material properties of igneous rocks afford ample criteria for establishing a systematic classification. . . . Since the geological factors of age, or of form, or place of occurrence, are not directly causes of the properties used in classification, they cannot be applied to produce coördinate groups."

Leucite Rocks from Montana. — In another paper Cross[1] reports the existence of a most interesting series of leucite rocks at the Leucite Hills and Pilot Butte, Wyoming. Some of these rocks have already been described by Zirkel, Emmons, and Kemp, but none of these geologists had learned of the great variety of types in the region. The principal area of leucite rocks is a mesa whose top consists of a surface flow of porous and massive rock material, the latter of which corresponds to Zirkel's leucitite, while the vesicular rock is a sanidine-leucite aggregate. The massive rock is redescribed by Cross as consisting of phlogopite crystals in a groundmass made up of leucite crystals and anhedra, separated from one another by pale green or colorless microlites of diopside, imbedded in a very siliceous glass. This rock the author calls *wyomingite*.

The principal rock of the Leucite Hills is the sanidine-leucite

[1] *Amer. Journ. Sci.*, vol. iv, p. 115, 1897.

aggregate referred to above. In addition to the two minerals mentioned, it contains also phlogopite, amphibole, and diopside. The phlogopite is in phenocrysts. The sanidine and the leucite are usually grouped in separate patches, the former in aggregates of stout, square prisms, associated with ophitic amphibole and with diopside, and the leucite in aggregates of minute anhedra, some of which are enclosed in amphibole prisms. The sanidine is filled with inclusions of diopside needles. The rock is called *orendite*. The amphibole of the orendite possesses very peculiar properties. While having a prismatic cleavage angle of 124°, its extinction appears always to be parallel to the c axis. Its pleochroism is $\mathfrak{a} = a$, pale yellow; $\mathfrak{b} = b$, red; $\mathfrak{c} = c$, bright yellow, and its axial figure is almost that of a uniaxial mineral.

The rock of Pilot Butte, a mesa separated from the Leucite Hills by a valley, is composed of colorless diopside, phlogopite, and, probably, perofskite, in a brown glassy base of the composition of leucite. This rock, which is probably a portion of a volcanic flow, is called *madupite*. The phlogopite of the madupite differs from that of the orendite in that it occurs as roundish grains filled with diopside microlites and perofskite grains. The cleavage is not as well marked as is usually the case in micas, but the optical properties are those of phlogopite.

The chemical composition of the three types of rocks is represented by the analyses following:

	Wyomingite	*Orendite*	*Madupite*
SiO_2	= 53.70	54.08	42.65
TiO_2	= 1.92	2.08	1.64
Al_2O_3	= 11.16	9.49	9.14
Fe_2O_3	= 3.10	3.19	5.13
FeO	= 1.21	1.03	1.07
CaO	= 3.46	3.55	12.36
BaO	= .62	.67	.89
MgO	= 6.44	6.74	10.89
K_2O	= 11.16	11.76	7.99
Na_2O	= 1.67	1.39	.90
H_2O at 110°	= .80	.79	2.04
H_2O above 110°	= 2.61	2.71	2.18
P_2O_5	= 1.75	1.35	1.52
Other constit.	= .80	1.14	1.71
Totals	100.40	99.97	100.11

The constituents included among the "other constituents" are ZrO_2, Ce_2O_3, Di_2O_3, Cr_2O_3, MnO, SrO, Li_2O, SO_3, Cl, Fl, and CO_2. The totals corrected for Fl are 100.21, 99.76, and 99.91.

The author points out the practical identity in the composition of the wyomingite and orendite, and concludes from this identity "that chemical composition of a magma does not alone determine whether leucite or sanidine shall be formed, but that this is controlled by conditions of consolidation."

A reclassification of leucite rocks is proposed, based on the quantitative importance of the leucite in them. The term leucitite is reserved for rocks in which leucite is the predominant component. Wyomingite and its granular equivalent are rocks in which leucite is of approximately equal importance with the ferro-magnesian-lime silicates. Orendite contains sanidine and leucite in about equal quantities. Both of these rocks are rich in silica. In madupite the heavy silicates predominate, leucite being in subordinate quantity. Its magma is low in silica.

Inclusions in the wyomingite and the orendite have been subjected to considerable contact action, the feldspars in the inclusions having suffered more than the bisilicates.

SCIENTIFIC NEWS.

THE collections of the late Professor Cope, which were bequeathed to the biological department of the University of Pennsylvania, have been turned over to the university. The most valuable of these are the books, the library containing many sets of journals, as well as a very large collection of monographs, separata, and books of reference. Next in order came the collection of skeletons of recent vertebrates, the nucleus of which was the collection of fish skeletons made by the late Professor Hyrtl, of Vienna, and purchased by Professor Cope over twenty years ago. These formed the basis of the work by Professor Cope on the classification of fishes. Besides, there were very considerable collections of shells and of minerals. The university has also received botanical collections from Biltmore, N. C., and from Prof. J. T. Rothrock.

The Washington Academy of Sciences is now organized, as a result of the affiliation of the various scientific organizations in that city. The officers for the present year are: president, J. R. Eastman; vice-presidents, J. W. Powell, L. O. Howard, H. N. Stokes, W. H. Ashmead, A. Graham Bell, Chas. D. Walcott, I. C. Busey, and F. H. Bigelow; secretary, G. K. Gilbert; treasurer, B. R. Green; managers, Marcus Baker, H. S. Pritchett, Geo. M. Sternberg, F. W. Clarke, C. Hart Merriam, Lester F. Ward, Frank Baker, and Carroll D. Wright.

Professor MacMahon, of Cornell University, has been elected general secretary of the American Association for the Advancement of Sciences, in place of the late Professor Kellicott.

The University of Pennsylvania will reopen its summer laboratory at Sea Island City, N. J., this summer. Dr. Milton Greenman will be in charge. It was established some eight years ago, but has been closed for the past five years.

On June 28–30, there will be conferences of science teachers in connection with the Omaha exposition; Prof. Conway Macmillan, of the University of Minnesota, will take charge of the botanical conference; Prof. Henry B. Ward, of the University of Nebraska, of the zoölogical conference; and a selection is yet to be made for the geological conference.

Is there anything in connection with science more exasperating than the attitude of the present city government of New York? The discharge of Dr. T. H. Bean from the directorship of the recently established aquarium, and his replacement by Col. James E. Jones, is one of the worst cases of the doctrine "to the victors belong the spoils" that has yet been brought to our notice.

Yale University desires funds for a building for physiological chemistry and for the completion of the Peabody Museum of Natural History.

The Smithsonian Institution has just issued a new edition of the catalogue of publications, issued under its auspices, with the prices at which those now in stock can be had. The total number of titles enumerated amounts to over 1000.

Prof. J. S. Kingsley goes with a party of Tufts College students to South Harpswell, Maine, for the summer. A house has been hired, and will be equipped as a laboratory.

The University of Berlin has conferred the degree of Doctor of Laws upon Prof. J. Victor Carus, the well-known editor of the *Zoologischer Anzeiger.*

Profs. Alphonse Milne Edwards and Raphael Blanchard will attend the International Zoölogical Congress, at Cambridge, as delegates from the University of Paris.

The University of Chicago has under consideration the establishment of a series of fellowships of the annual value of $750, to be granted to students who have received the degree of Doctor of Philosophy from that institution. These fellows are to devote their time solely to investigation. The fellowships are to be awarded annually, but incumbents will be eligible to reëlection for a period not to exceed five years. Such a series of fellowships will be a great stimulus to research.

Prof. Friedrich Körnicke has resigned the chair of botany at the Poppelsdorf Agricultural School, connected with the University of Bonn.

Recent appointments: Prof. W. P. Blake, of Tucson, geologist of Arizona.—Mr. E. G. Coghill, of Brown University, assistant in biology in the University of New Mexico.—Mr. F. S. Maltby, of Johns Hopkins University, assistant in the bacteriological laboratory of the

University of New Mexico. — Dr. F. Noll, professor of botany in the Poppelsdorf Agricultural School at Bonn. — Surgeon Major David Prain, superintendent of the Botanical Gardens at Calcutta. — Dr. Heinrich Ries, instructor in economic geology in Cornell University. — Prof. John Weinzetl, of Madison, Wisconsin, director of the bacteriological laboratory and associate professor of biology in the University of New Mexico.

Recent deaths: Alfred Allen, at Bath, England, formerly editor of the *Journal of Microscopy and Natural Science*, March 24, aged 64. — Melville Atwood, geologist and metallurgist, at Berkeley, California, April 25, in his 88th year. — John Shearson Hyland, petrologist, on the west coast of Africa, April 19, aged 32. — Dr. F. Sandberger, professor of mineralogy in the University of Würzburg, aged 72.

PUBLICATIONS RECEIVED.

Annales de la Société Royale Malacologique de Belgique. Tome xxviii (Ann. 1893); tome xxix (Ann. 1894), 1896; tome xxxi (Ann. 1896), 1896. — *Bulletin of the Johns Hopkins Hospital.* Vol. ix, No. 86, May. — *The Forester.* Vol. iv, No. 5, May. — *Geographical Magazine.* Vol. xi, No. 5, May. — *The Industrialist.* Vol. xxiv, No. 6. Manhattan, Kansas, June, 1898. — *Jenaische Zeitschrift für Naturwissenschaft.* Bd. xxxii, Hefte 1, 2. 1898. — *Journal of the Franklin Institute.* Vol. cxlv, No. 5, May, 1898. — *The Kansas University Quarterly.* Vol. vii, No. 2, April. — *Knowledge.* Vol. xxi, No. 151, May. — *Linnean Society of New South Wales.* Abstract of Proceedings, March 30, 1898. — *Medical and Surgical Reporter.* Vol. lxxviii, No. 3, April 16. — *Memorias y Revista de la Sociedad Cientifica.* "Antonio Alzate." Tome xi (1897–98), Nos. 1–4. Mexico, 1898. — *Michigan State Board of Agriculture.* Thirty-fifth Annual Report. Lansing, 1897. — *North American Journal of Diagnosis and Practice.* Vol. i, No. 4, April. St. Louis, Mo. — *The Open Court.* Vol. xii, No. 5, May. — *Proces-Verbaux des Séances de la Société Royale Malacologique.* Tome xxv (Ann. 1896). — *Publications of the Louisiana Historical Society.* Vol. ii, Pt. i, 1898 (1897). The Mounds of Louisiana, by GEO. E. BEYER. — *U. S. Geological Survey.* Eighteenth Annual Report, 1896-97. Vol. ii, Pt. v. Washington, 1897. — *The Zoölogist.* Fourth Series, Vol. ii, No. 16. London, April, 1898.

(*Number 377 was mailed June 24.*)